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1980

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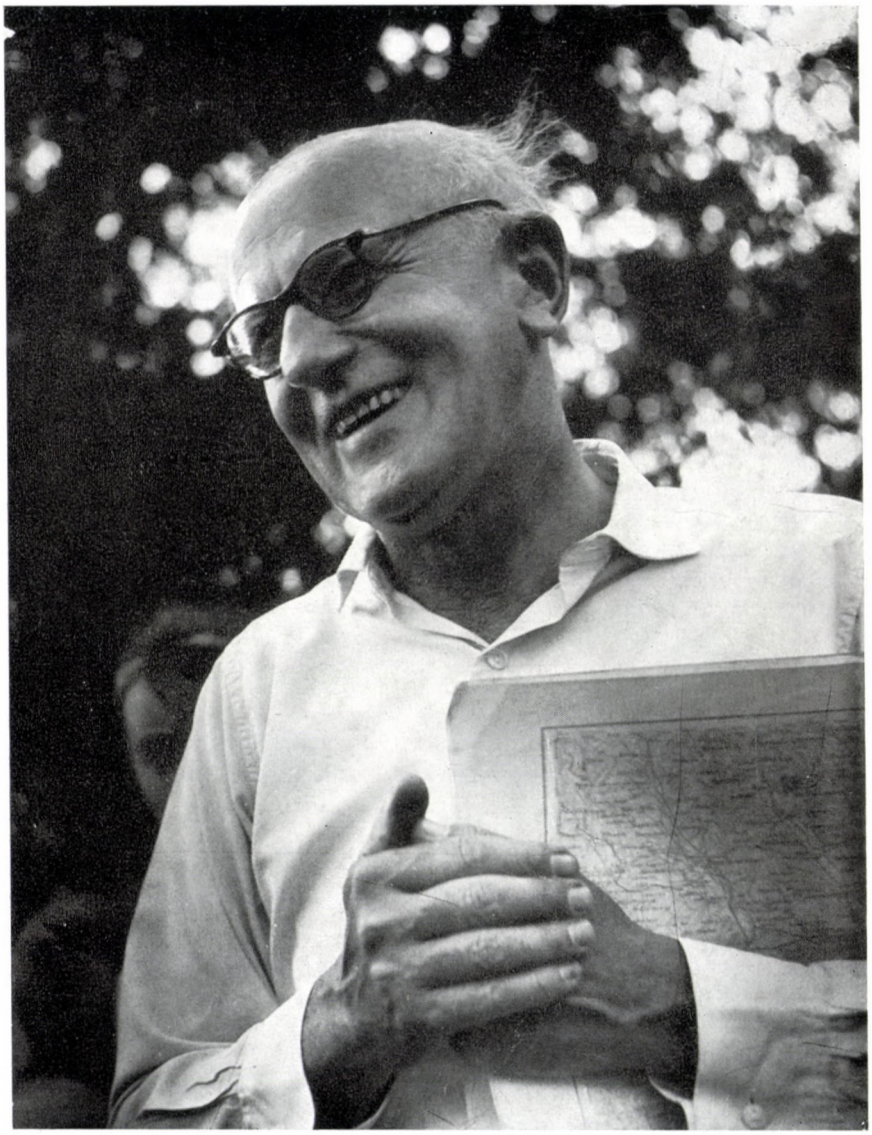

MAGYAR TUDOMÁNYOS AKADÉMIA KÖNYVTÁRA

Acta Botanica Academiae Scientiarum Hungaricae, Tomus 26 (1—2), pp. 3—14 (1980)

PROF. DR. BÁLINT ZÓLYOMI

Die ungarische Botanik begrüßt herzlich Herrn Prof. Dr. Bálint ZÓLYOMI aus dem Anlaß, daß er sein siebzigstes Lebensjahr vollendet hat. Sie wünscht, daß er noch lange in guter Gesundheit und mit dem für ihn kennzeichnenden dynamischen Schwung an den der Zukunft dienenden umweltbiologischen Wissenschaftsarbeiten teilnehmen soll!

Der Almanach der Ungarischen Akademie der Wissenschaften (1976) erwähnt folgende, von Bálint ZÓLYOMI kultivierte Wissenschaftsgebiete: Pflanzenzönologie—Synökologie, Palynologie, Umweltbiologie. Er ist tatsächlich ein weitblickender, moderner Wissenschaftler von interdisziplinärer Anschauung, der mit seinem ganzen Lebensweg, mit seiner ganzen Arbeit die Entwicklung der heutigen Natur- und Umweltschutzforschungen vorbereitet und befördert hat. Vor allem erhebt die Botanik Anspruch auf seine Ergebnisse, aber ähnlicherweise zählt er für einen Pfleger der Geographie, Geologie, Klimatologie, Forstwissenschaft, usw. Sich auf die Botanik stützend interessierte er sich schon in seiner Jugend für die Erkenntnis der Beziehungen und Zusammenhänge der belebten und unbelebten Welt und seine sämtlichen Arbeiten und Lehren widerspiegeln eine komplexe Anschauungsweise und eine weitumfassende ökologische Auffassung.

Er wurde am 31. Mai, 1908 in Preßburg geboren. Er kam als Zwölfjähriger nach Győr, wo er dank seinem Mittelschullehrer, Dr. Sándor POLGÁR, seiner früheren Träume in Verbindung mit der Malerei absagte und sich mit der Botanik verlobt hat. Er begann seine Universitätsstudien an der Universität zu Budapest (1927—1930) und beendete sie (1931) an der Universität zu Debrecen. Er arbeitete drei Jahre lang neben Prof. Rezső Soó und später für eine lange Zeit neben Prof. Sándor JÁVORKA.

Er habilitierte in historischer Pflanzengeographie an der Universität Debrecen und 1940 in Pflanzensoziologie an der Universität zu Budapest, wo er 1964 den Professorentitel erlangt hat. Seine Spezialkollegien konnten von dem Großteil der heute leitenden ungarischen botanischen Fachleute angehört werden, er hielt außerdem für Geologen Vorlesungen über Palynologie, für Forstwissenschaftler über Waldtypologie und — auf Universitätsniveau

zuerst in Ungarn — für 5 Jahre an der Universität für Gartenbau Vorlesungen über Natur-, sodann Umweltschutz.

Sein wichtigstes und leidenschaftlich geliebtes Arbeitsgebiet war aber immer die Forschung. Er arbeitete in der Botanischen Abteilung des Naturwissenschaftlichen Museums des Ungarischen Nationalmuseums seit 1934 und leitete diese zwischen 1950—1966. Mittlerweile war er zwischen 1940—1946 Direktor des Loránd Eötvös Kollegiums in Szeged. 1954 wurde er Direktor des Botanischen Forschungsinstituts der Ungarischen Akademie der Wissenschaften (Vácrátót) und versah diese Arbeit bis 1966 gleichzeitig mit seiner Tätigkeit in der Botanischen Abteilung. Zwischen 1966 und Ende 1977 arbeitete er — seine Stellung in der Botanischen Abteilung aufgebend — als Leiter des Botanischen Forschungsinstituts.

In der Anfangsperiode seiner Forschungen konnte er an den Schlußarbeiten der mittels einer kollektiven Arbeit durchgeführten Florenaufschließungen teilnehmen. Er ergänzte seine floristischen Daten bereits damals immer durch standörtlich-zönologisch-historische Auseinandersetzungen und Bemerkungen. Er trieb aus seinen auf ökologische Kenntnisse begründeten bewußten floristischen Nachforschungen wahrhaftig einen Sport (»da muß es sein!«). Aus seinen neuen ausländischen Funden können *Urtica kioviensis* aus Deutschland (1935), die einzigen Standorte von *Carex heleonastes* und *Galium saxatile* in der Bergkette der Karpaten (1942), sowie *Diotis candidissima* aus Bulgarien und vom Ufergebiet des Schwarzen Meeres (1956) erwähnt werden.

Er war der erste in Ungarn, der in die vegetationshistorischen (später geologischen) Forschungen die Methode der Pollenanalyse einführte. Noch als Universitätshörer in Budapest hat er die notwendigen Schichtenaufschließungen in den Torfmoosmooren von Kelemér und Egerbakta in Nordungarn durchgeführt und als Ergebnis der Bearbeitung die postglaziale Klima- und Vegetationsgeschichte des Bükk-Gebirges und seiner Umgebung dargestellt (1930—1931). Später untersuchte er — nach der Weiterentwicklung der Probeentnahmemethode der statistischen Bearbeitung von Pollenanalysen — vor allem die Ablagerungen des Balaton. Auch seine Antrittsvorlesung anläßlich seiner Erwählung zum korrespondierenden Mitglied der Ungarischen Akademie der Wissenschaften stützt sich auf dieses Material (»Die Entwicklungsgeschichte der Vegetation Ungarns seit dem letzten Interglazial«, 1952—1953). Seine pollenanalytischen Arbeiten auch seitdem weiterführend, hat er den Aufschwemmungsgang des Balaton geklärt und gab — unter anderem — auch damit Beweise für die vielumstrittene Entstehungszeit des Sees. Seine Untersuchungen lieferten wertvolle Daten auch hinsichtlich der Rolle der anthropogenen Tätigkeit, mit Bezug auf das vergangene und gegenwärtige Leben des Sees (1971, 1980).

Bálint Zólyomi erreichte hervorragende Ergebnisse auch in der Erkennung der ungarischen Vegetationseinheiten. Zuerst meldete er sich mit Moor-

und Felsrasenstudien (1931—1943), verfaßte sodann später seine Abhandlung über »Die Vegetation des Budaer Gebirges«, worin er auch die Synthese seiner phytozönologischen Ergebnisse aus dem Transdanubischen Mittelgebirge veröffentlichte (1950, 1958). Auch auf dem Gebiet der phytozönologischen Aufschliessung der ungarischen und südosteuropäischen Lößvegetation hat er eine höchst wertvolle Arbeit geleistet. Die noch bestehenden Flecke besuchend, hat er die Rasen-, Strauch- und Waldassoziationen der Lößwaldsteppen komparativerweise bearbeitet und dadurch das originelle, potentielle Vegetationsbild der heutigen, nunmehr bebauten Großen Ungarischen Tiefebene in ein neues Licht gestellt (1957—).

In seinen phytozönologischen Arbeiten hat er die Synthese solcher allgemeinen pflanzengeographischen Fragen angegeben und ihnen eine moderne Basis von dynamischer Anschauung verliehen, wie das Dolomitphänomen und die Bedeutung der Florenscheide des mittleren Donaudurchbruchs (1942), die moderne Interpretierung der Urmátra-Theorie (1958), fernerhin zahlreiche Gesetzmäßigkeiten des Zusammenhangs von Vegetation und ihrer Umgebung (Boden, Relief, Mikroklima).

Im Zusammenhang mit seinen zönologischen Forschungen hat er zahlreiche detaillierte Vegetationskarten verfertigt (die Moore Kelemér, Hanság, Bátorliget, das von Kőszeg, Kukojszás, usw.) und die Vegetationsskizze (1936) dargestellt, und verfertigte in 1967 für den ungarischen Nationalatlas unsere noch heute angenommene, moderne, potentielle, heimische Vegetationskarte im Maßstab von 1 : 1 500 000, die er anläßlich seiner Erwählung zum Mitglied der Akademie (1970) bekanntgegeben hat.

Unter den weitreichenden Arbeiten von Bálint Zólyomi sind seine, zusammen mit Nándor Bacsó im Bükk-Gebirge durchgeführten Mikroklimamessungen in Ungarn ebenfalls neuartig gewesen (1934—1935). Er gab mit dieser Arbeit das Modell zu zahlreichen Mikroklima-Messungsuntersuchungen. Die 1958 veröffentlichte, neuartige Methode der Analyse des Jahresganges der Niederschlagsverteilung beweist effektvoll die Korrelation zwischen der Häufigkeit der Jahre von verschiedener Niederschlagsgänge und der räumlichen Anordnung der Arealtypen der Pflanzenarten.

Unsere Regierung hat 1955 die auf dem Gebiet der Waldtypologie entfaltete Tätigkeit von Bálint Zólyomi mit dem Kossuthpreis gewürdigt. Er bearbeitete nämlich und wandte auf die ungarischen Verhältnisse die mehrdimensionale Klassifizierung der sowjetischen Waldtypologie an und brachte diese mit den westeuropäischen phytozönologischen Systemen in Einklang. Gerade als Ergebnis dieser Arbeiten wurde in Ungarn von seiten der Forstwissenschaftler die intensive Forschung der Waldtypologie und ihre praktische Anwendung in Gang gesetzt (1954—1963).

Es ist demnach kein Zufall, daß die heimische Einführung der auf der ganzen Welt begonnenen produktionsbiologischen Forschungen (IBP) auch

mit dem Namen von Bálint ZÓLYOMI verbunden ist. Es besteht kein Zweifel, daß die in den mosaikartigen Steppenvegetationseinheiten der alkalischen Waldsteppe bei Újszentmargita in Team durchgeführten produktionsbiologischen Forschungen den Ausgangspunkt zu den heutigen, modernen Forschungsrichtungen auf dem Gebiet der Umweltbiologie und Umweltschutz bildeten (1967—).

Bálint ZÓLYOMI unternahm in den vergangenen Jahrzehnten außer seinen wissenschaftlichen Forschungen auch eine bedeutende wissenschaftsorganisatorische und -leitende Arbeit. Er organisierte und modernisierte die Botanische Abteilung des Naturwissenschaftlichen Museums, sodann das Botanische Forschungsinstitut der Ungarischen Akademie der Wissenschaften in Vácrátót. Sein ausgezeichneter praktischer Sinn, sein Organisationstalent, seine vielseitige Informiertheit und immer fortschrittliche, gemeinschaftliche Gesinnungsweise trugen dazu bei, daß er auch die schwierigsten Aufgaben erfüllen konnte. Er nahm an der Arbeit zahlreicher Kommissionen teil und beteiligt sich auch heute noch an ihnen mit großer Aktivität.

Eines seiner neueren Aufgabenbereiche war die Organisierung und internationale Koordination der ungarischen Biosphärenforschungen (1971—). Als Leiter der fernöstlichen Delegation der Ungarischen Akademie der Wissenschaften schloß er zum ersten Mal wissenschaftliche Kooperationsabkommen mit den Akademien von Mongolien, Korea und Vietnam (1959). Das Exekutivkomitee der 1923 gegründeten Internationalen Union der Biologischen Wissenschaften (IUBS) erwählte in seiner Person zum ersten Mal ein ungarisches Mitglied (1967—1973). Mit seinen Vorlesungen an internationalen Kongressen, Symposien und an ausländischen Universitäten, mit seinen Referaten und seiner aktiven Teilnahme an verschiedenen Delegationen repräsentierte er öfters die ungarischen Forschungsergebnisse auf der ganzen Welt (Bergen, Berlin, Bern, Bratislava, Brüssel, Eberswalde, Edinburgh, Frankfurt a. Main, Göttingen, Halle, Innsbruck, Klagenfurt, Krakau, Leningrad, Lvov, Moskau, Neapel, Paris, Prag, Seattle, Sofia, Stockholm, Stolzenau, Uppsala, Washington, Wien, Zürich, usw.).

Er wurde von der Ungarischen Geographischen Gesellschaft (1965) und von der Tschechoslowakischen Botanischen Gesellschaft zum Ehrenmitglied erwählt. Der Präsidialrat der Ungarischen Volksrepublik hat ihn zweimal, in 1968 und 1977, mit dem »Goldenen Grad des Ordens der Arbeit« ausgezeichnet.

Das bisherige — noch von weitem nicht abgeschlossene — Lebenswerk von Bálint ZÓLYOMI ist die Arbeit eines wirklichkeitstreuen, modernen Ökologen von komplexer Anschauung, der von allen heimatsliebenden und in der Zukunft mit wissenschaftlicher Gründlichkeit wirkenden jungen Naturwissenschaftlern mit Recht zum Vorbild genommen werden kann.

P. JAKUCS

WISSENSCHAFTLICHE PUBLIKATIONEN UND ANDERE MITTEILUNGEN VON DR. BÁLINT ZÓLYOMI

A győri homokpuszták növényzete. (Die Vegetation der Sandgebieten bei Győr. Nur ung.) — Ifjúság és élet, 2, 1927, p. 305—308.

Adatok a Bükk-hegység és környéke flórájához. (Beiträge zur Flora des Bükkgebirges und seiner Umgebung.) — Magyar Botanikai Lapok, 26, 1928, p. 63—64.

A keleméri „Mohos"-tavak. (Die »Mohos« Moore bei Kelemér. Nur ung.) — Ifjúság és élet, 4, 1929, p. 271—274.

A Hanság vegetáció- és flóratörténetének legújabb korszaka. (Vegetation- u. Florengeschichte des Hanság. Vortragsauszug.) — Bot. Közl. 27, 1930, p. 126, 128.

A Kis-Alföld páfrányairól. (Über die Farne des Kis-Alföld.) — Bot. Közl. 28, 1931, p. 189—191.

Adatok a Hanság flórájához I. (Beiträge zur Flora des »Hanság« I.) — Bot. Közl. 28, 1931, p. 191—192.

A Bükkhegység környékének Sphagnum lápjai. (Vegetationsstudien an den Sphagnummooren um das Bükkgebirge in Mittelungarn.) — Bot. Közl. 28, 1931, p. 89—121. (Mit 2 Vegetationskarten, 1 : 2000.)

Klíma- és növénytakaró változások a jégkorszak óta a Bükkhegység vidékén. (Klima- und Vegetationsänderungen seit dem Pleistozän um das Bükkgebirge in Mittelungarn.) — Debreceni Tisza I. Tud. Társ. II. O. Munkái, 4, 1931, p. 111—114.

A kultúra hatása a vegetációra a Hanság medencéjében. (Die Einflüsse der Kultur auf die Vegetation des Moorgebietes »Hanság«.) — Debreceni Tisza I. Tud. Társ. II. O. Munkái, 4, 1931, p. 120—128.

L'histoire de Méleze européen. — Bulletin de la Société Botanique de la France, Paris, 79, 1931, p. 663—666.

Rezension über Rudolph, K.: Grundzüge der nacheiszeitlichen Waldgeschichte Mitteleuropas. (Nur ung.) — Bot. Közl. 28, 1931, p. 85—86.

Rezension über Soó, R.: Nomenclator Borbásianus I. (Nur ung.) — Bot. Közl. 28, 1931, p. 194.

Adatok a Hanság flórájához II. (Beiträge zur Flora des »Hanság« II.) — Bot. Közl. 29, 1932, p. 153—154.

A Bükkhegység sziklai növényzetének szociológiai vizsgálata. (Die Felsenvegetation des Bükkgebirges.) — Néhány gondolat az Ősmátra flóra- és vegetációtörténetéhez. (Fragmente zur Floren- und Vegetationsgeschichte d. Ősmátra. Vortragsauszüge.) — Bot. Közl. 30, 1933, p. 112, 118.

A Hanság növényszövetkezetei. (Die Pflanzengesellschaften des Hanság.) — Vasi Szemle (Folia Sabariensia) 1, 1934, p. 146—174. 1 Vegetationskarte (1 : 100 000).

Dracocephalum austriacum L. a Bélkőn. (Adatok az Ősmátra flórájához.) Dracocephalum austriacum L. auf dem Bélkő. (Beiträge zur Flora des Ungarischen Mittelgebirges.) — Bot. Közl. 31, 1934, p. 35—37.

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NOTAS SOBRE BIGNONIÁCEAS CUBANAS, I.

ESPÉCIES NUEVAS DEL GÉNERO TABEBUIA EN CUBA

Por

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(Llegado 10 de Marzo, 1979)

Author describes 7 new taxa, 5 species, a hybrid and a variety of the genus *Tabebuia* (*Bignoniaceae*) from Cuba. All the taxa are endemic to the flora of Cuba and new to science. They are: *Tabebuia perelegans* sp. n., *T. zólyomiana* sp. n., *T. triorbicularis* sp. n., *T. triorbicularis* Borhidi var. *obovata* var. n., *T. capotei* sp. n., *T. del-riscoi* sp. n., *T.* × *rosariensis* hybr. n.

Tabebuia perelegans Borhidi **sp. n.**

Frutex vel arbor parva. Rami hornotini purpureo-brunnei vel nigrescentes, longitudinaliter striati, nitidi, sparse brunneo-lepidoti, lenticellis linearibus albis obsiti, veteriores non visi. Folia 2—4 cm longe petiolata, petiolis striatis nitidisque brunneis, sparse minuteque lepidotis suffulta, 3—5-foliolata. Foliola lanceolata vel lineari-lanceolata, apice obtusa, basi rotundata; centralia 4—7,5 cm longa et 1,2—2,2 cm lata, 1—2,5 cm longe petiolulata, basalia sessilia, basi valde obliqua, centralibus leviter minora; nervo medio supra impresso, subtus valde prominenti, lateralibus utroque latere 7—9 supra obsolete impressis et reticulatis, subtus albis, tenuiter prominentibus et densissime reticulato-anastomosantibus; lamina supra nitidiuscula, sine lepidibus glaberrima, subtus albescens et squamis brunneis minutis satis dense lepidota; margine integra, tenuiter recurva, coriacea.

Flores solitarii axillares, 2,5—6 cm longe pedunculati, bracteae caducae. Calyx fructifer 8—9 mm longus et apice 6—7 mm latus, breviter 5-lobatus, in sicco niger, non lepidotus. Corolla non visa. Capsula 7—9 cm longa, 5—8 mm lata, 4-angulata, elepidota, apice breviter apiculata. Semina transversaliter oblonga, latitudo longitudine duplo major, apice emarginata, 4—5 mm longa et 8 mm lata, cum alis pergamaceis 15 mm lata.

Holotypus: 26886 HAJB; Cuba; Prov. Guantánamo (Oriente); Orillas del Rio Báez, cerca de Los Naranjos, Sierra de Iberia. Leg.: J. BISSE, L. GONZALEZ, et F. K. MEYER, 1—3. aug. 1975. Isotypi: HAC, JE, BP.

Obs.: *Tabebuiae elegantis* Urb. affinis, quae a specie nostra ramulis glabris, foliolis basalibus petiolulatis, foliis subtus brunneis, floribus 1—2,5 cm longe pedunculatis, calyce 10—12 mm longo, fructibus oblongo-ellipticis, 3—4 cm longis, 1 cm latis, cylindraceo-striatis, non angulatis, coriaceis lepidotisque bene differt.

Tabebuia zólyomiana Borhidi **sp. n.**

Arbor parva, usque ad 10—12 m alta. Rami hornotini leviter quadrangulati, brunnei, nitidi, longitudinaliter striati, sparse impresso-punctati, veteriores albescentes, teretes, leviter striati. Folia 1,5—3,5 cm longe petiolata, petiolis 1,5—2 mm crassis, glabrisque, supra anguste

canaliculatis suffulta; foliola 3 vel 5, basalia 2—4 mm, cetera 1—2 cm longe petiolulata, oblongo-ovata vel oblongo-elliptica, basi rotundata vel breviter cordata, basalia leviter asymmetrica, apice breviter acuminata et obtusa, 5—12 cm longa et 1,8—4,8 cm lata; nervo medio supra tenuiter impresso, subtus prominenti, lateralibus utroque latere 7—11, supra insconspicuis vel levissime impressis, subtus leviter prominulis et ante marginem obsolete conjunctis et

Fig. 1. Holotipo de la *Tabebuia zólyomiana* Borhidi (LF 1843 HAC)

minutissime prominenter reticulatis; lamina supra nitida, glabra, dense minuteque impresso-punctata, plerumque levissime rugulosa, subtus opaca, brunnescens, in venis minutissime sparseque ferrugineo-lepidota ceterum sparsissime impresso-punctata, margine integra, plana, rigide coriacea.

Inflorescentiae terminales, 3-florae, glabrae. Pedunculi 1—2 cm longi, pedicelli 1,5—2(4) cm longi, medio bibracteati, sparse ferrugineo-lepidoti. Calyx 10—12 mm longus, campanulatus, obsolete 3-lobatus, glaber, lobi plerumque aequimagni. Corolla purpurea, 5—6 cm longa, infundibuliformis. Capsula 10—13 cm longa, utrinque longe attenuata, minute et sparse brunneo-lepidota.

Holotypus: LF 1843 HAC; Cuba; Prov. Holguin (Oriente), Sierra de Nipe. Cayo Rey, Pinar de Bio, márgenes del Arroyo Potrero. Leg.: M. López Figueiras, 31. jan. 1955. Isotypi: HAC, HAJB.

Specim. exam.: 1867 LF Sierra de Nipe; Cayo Rey, Arroyo Canapu, Leg.: M. López Figueiras 18. febr. 1955. — 1854 LF. Cayo Rey, Rio Bio. Leg.: M. López Figueiras 31. jan. 1955.

Obs.: *Tababuiae pachyphyllae* Britt. affinis, quae a specie nostra foliis majoribus, longius petiolatis, nervis lateralibus supra prominulis, lamina foliolorum supra epunctata, inflorescentiis, inclusive pedunculis pedicellisque brevioribus et calycibus minoribus bene differt.

Obs. II.: Hanc speciem in honorem cli. D-ris Bálint Zólyomi, academici et professoris botanicae, directoris emeriti Instituti Botanicae Academiae Scientiarum Hungaricae in scientiis palynologiae et historiae vegetationis atque geobotanicae, phytocoenologiae cartographiaeque vegetationis excellentissimi in occasione septuagesimi anniversarii nativitatis dedicavi.

Tabebuia triorbicularis Borhidi **sp. n.**

Frutex usque ad 4—5 m altus. Rami hornotini angulosi, striati, nigro- vel postremo albo-lepidoti, lenticellis ovatis grandis sparse suffulti, veteriores nitidi, albi, elepidoti, postremo brunnei, fissurato-striati. Folia 3-foliolata, 1—2,5 cm longe petiolata, petiolis supra sulcatis, albo-lepidotis suffulta; foliola suborbicularia, orbiculari-obovata vel orbiculari-elliptica, apice rotundata et profunde excisa, basi obtusa, rotundata vel truncata, centralia 2—4 cm longa et 1,5—3 cm lata, 0,5—1,5 cm longe petiolulata, lateralia minora, 1,5—3 cm longa et 1,2—2,3 cm lata et 1—3 mm longe petiolulata, leviter obliqua; nervo medio supra profunde impresso, subtus crassiuscule prominenti, lateralibus utroque latere 5—7, supra impressis et ante marginem conjunctis, subtus basi domatiiformiter incrassatis, valde prominentibus, sub angulo 60—70° abeuntibus, ante marginem arcuato conjunctis et anastomosantibus reticulo laxo; lamina utrinque albicans, lepidibus albis densissime obtecta et squamis majoribus brunneis sparse intermixta, margine integra, coriacea.

Inflorescentiae terminales cymoso-paniculatae, 5—9(11)-florae. Pedunculi 1,5—2,5 cm longi, pedicelli usque ad 1 cm longi, bracteae binae 3—5 mm longae, lineares, subulatae, supra medium pedicelli affixae, brunneo- vel nigro-lepidotae et apicem versus ferrugineo-puberulae postremo caducae. Calyx campanulatus, 7—10 mm longus, apice 5—6 mm latus, densissime nigro-lepidotus, subaequaliter 5-lobatus, lobi late triangulares, 1—2 mm longi; corolla sanguineo-purpurea, tubulari-campanulata, 3,5—4 cm longa, tubus 2,5—3 mm longus et sub lobis 5 mm latus, lobi inaequales, inferiores 5—8 mm longi et lati. Capsula 5—7 cm longa, 4-angulosa et striata, apice subulato-acuminata, nigro-lepidota. Semina 5 mm longa et 5—7 mm lata, cum alis pergamaceis 13—18 mm lata.

Holotypus: 34762 HAJB; Prov. Cienfuegos (Las Villas), Trinidad; Loma del Burro, in alt. 400—600 m sobre roca caliza. Leg.: J. Bisse, A. Dietrich, J. Gutierrez, H. Lepper, 4. Mai 1977. Isotypi: HAC, HAJB, JE, BP.

Obs.: Foliis 3-foliolatis, orbicularibus, utrinque densissime albo-lepidotis inter omnes species cubanas huius generis insignis.

var. obovata Borhidi **var. n.**

A typo foliolis oblongo-obovatis, 4—7 cm longis, 2—3 cm latis, basi attenuatis et obtusis, nervis lateralibus 5—9, calycibus oblongo-campanulatis, 10—13 mm longis, bilobatis, usque ad 2 cm longe pedicellatis differt.

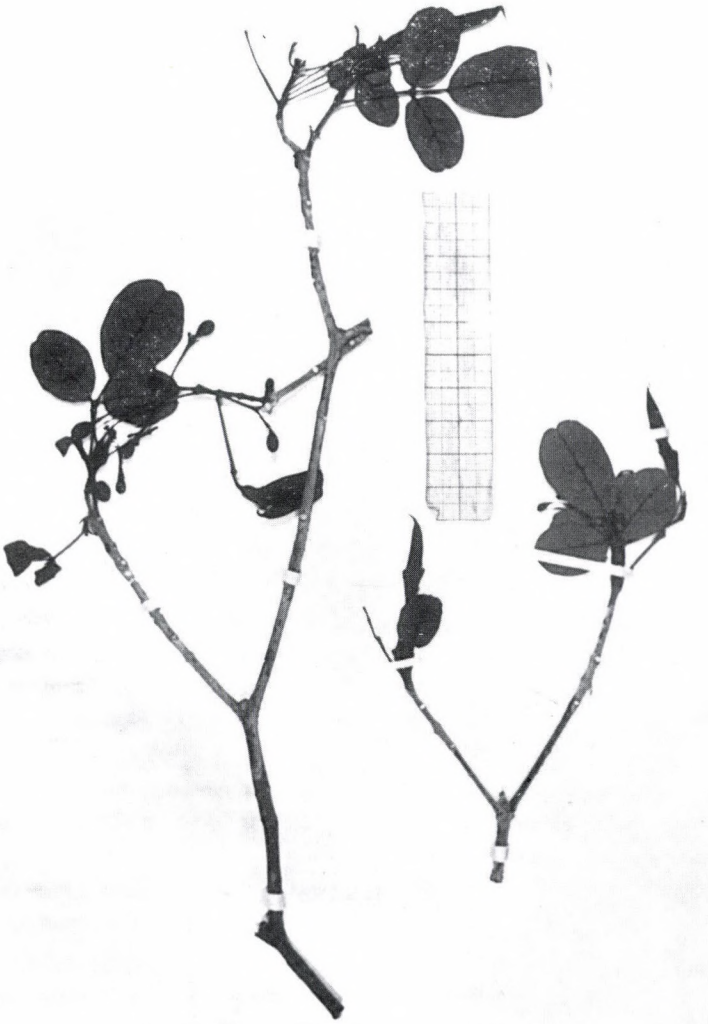

Fig. 2. Isotipo de la *Tabebuia triorbicularis* Borhidi (HAJB 34762 in BP)

Holotypus: Cuba; Prov. Sancti Spiritus (Las Villas); Trinidad; Loma del Mirador, carretera a Topes de Collantes, alt. cca 550 m. Leg.: J. Bisse, A. Dietrich, J. Gutierrez et H. Lepper, 3. Mai 1977. HAJB. Isotypi: HAC, JE, HAJB, BP.

Tabebuia capotei Borhidi **sp. n.**

Arbor parva usque ad 4—5 m alta. Rami veteriores teretes, albescentes, glabri, lenticellis ovalibus et cicatricibus foliorum semiorbicularibus gibberosi et longitudinaliter striati, hornotini lepidibus ferrugineis minutis laxe dispositis obsiti. Folia petiolis 4—20 mm longis,

Fig. 3. Isotipo de la *Tabebuia triorbicularis* var. *obovalis* Borhidi (BP)

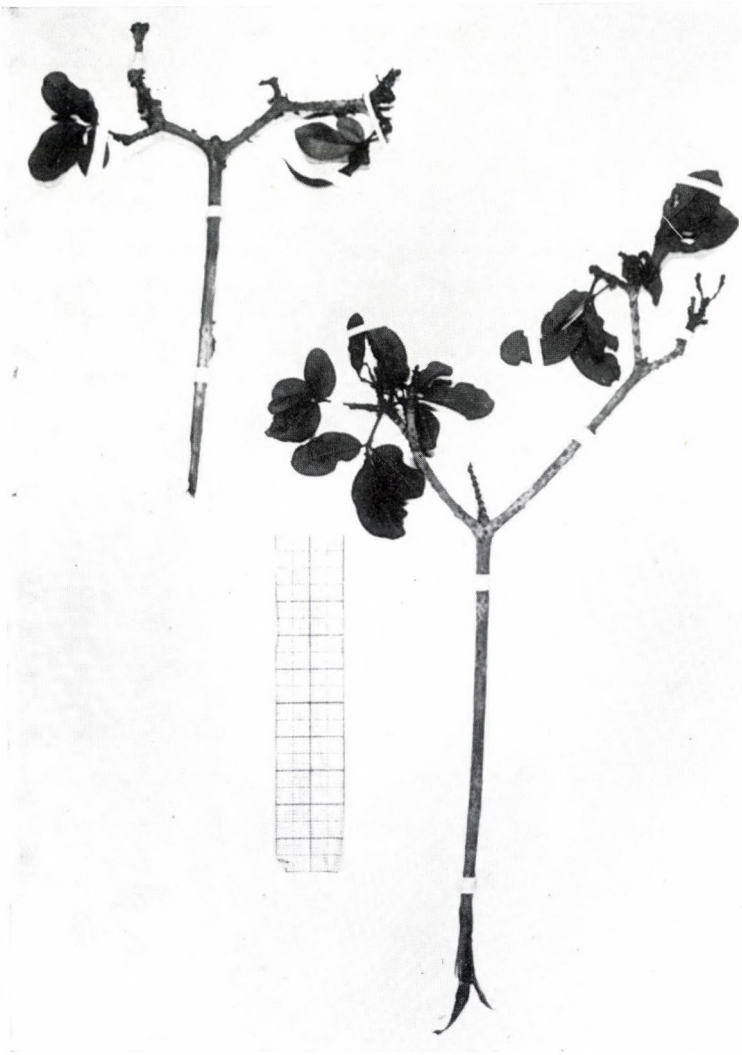

Fig. 4. Isotipo de la *Tabebuia capotei* Borhidi (HAC 27811 in BP)

1—1,5 mm crassis, supra leviter sulcatis suffulta; foliola 3 rariter 2 vel 1, terminale 2—4 mm longe petiolatum, lateralia subsessilia, omnia ovata vel late elliptica, basi rotundata vel breviter cordata, lateralia inaequilatera, antice rotundata et breviter emarginata vel brevissime acuminata et obtusa, 2—4 cm longa et 1—2,3 cm lata; nervo medio supra (plerumque in sulco) prominulo, lateralibus utroque latere 4—6 supra tenuiter prominulis, subtus bene prominentibus, supra minutissime, subtus minute reticulata, reticulo utrinque prominulo; lamina supra nitida, plerumque concaviuscula, superne albo-lepidota, subtus pallidior, ferrugineo-brunnescens, opaca, minute sparseque albo- vel ferrugineo-lepidota, basi impresso-punctata, margine plana, irregulariter obsolete denticulata, coriacea.

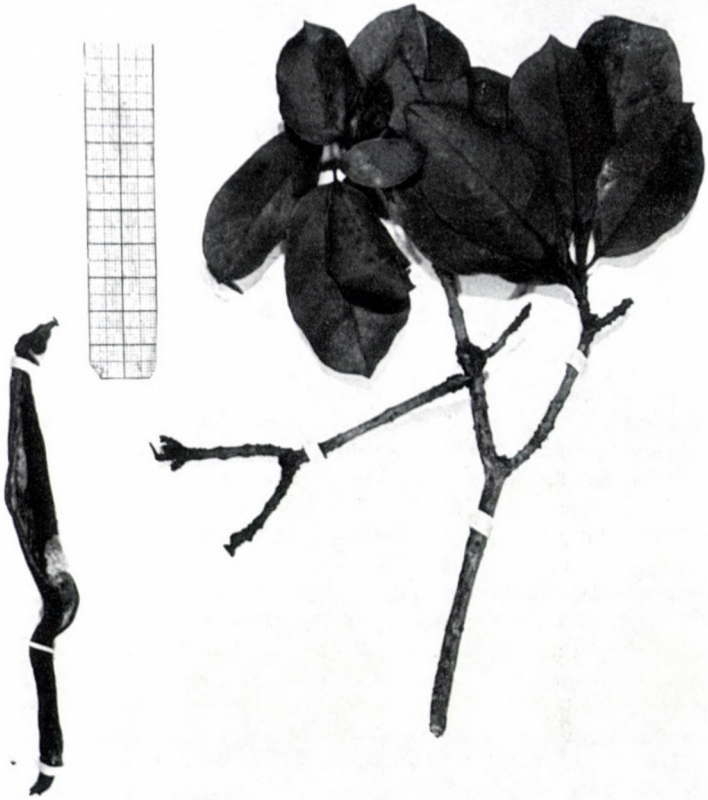

Fig. 5. Isotipo de la *Tabebuia del-riscoi* Borhidi (HAC 27843 in BP)

Inflorescentiae terminales corymbosae, 1—3-florae, sparse ferrugineo-lepidotae; pedicelli 5—15 mm longi, in vel sub medio 1—2-bracteolati; bracteolae filiformes cca 1 mm longae. Calyx 8—10 mm longus, superne valde ampliatus, in statu compresso 6—8 mm latus, bilabiatus, sparsissime brunneo-lepidotus. Corolla pallide rosea, 5—6 cm longa, tubus e basi angustato valde ampliatus, glaber. Capsula 8—15 cm longa, apice longe acuminata, sparse lepidota.

Holotypus: Cuba Occidentalis; Prov. Pinar del Rio; Peninsula de Guanahacabibes; in silvis fruticosis litoralibus calcareis ad viam Bolondrón, Punta del Holandés. Leg.: A. Borhidi et R. Capote 10. oct. 1977. HAC 27811; Isotypus: BP.

Specimina examinata: Ibidem, leg.: E. DEL-RISCO et R. CAPOTE 5. aug. 1977. — Peninsula de Guanahacabibes, Punta Leones, Cabo Corrientes; leg.: A. BORHIDI et R. CAPOTE, 11. oct. 1977.

Obs.: *Tabebuiae beyeri* Urb. et Ekm. affinis, quae a specie nostra ramis elenticellatis, foliis majoribus, planis, subtus glaucescentibus, nervis lateralibus 5—8, floribus rubris 2—2,5 cm longe pedicellatis, calycibus 12—13 mm longis, superne vix ampliatis bene differt.

Obs. II.: Hanc speciem Lic. RENÉ CAPOTE botanico cubano, in phytocoenologia et cartographia vegetationis studiosissimo dedicavi.

Tabebuia del-riscoi Borhidi **sp. n.**

Arbor parva, usque ad 6—8 m alta. Ramuli hornotini cum pseudo-stipulis linearibus sparse ferrugineo-lepidoti, veteriores teretes, striati, cinerascentes, cicatricibus atque lenticellis crasse prominentibus irregulariter verrucosi. Folia 1- vel 3-foliolata, 7—25 mm longe petiolata, petiolis striatis, supra applanatis, squamis concoloribus lepidotis suffulta, solitaria late ovata vel obovata, basi rotundata vel obtusa, apice breviter acuminata, apiculata et acuta, 4,5—7 cm longa et 2,5—4 cm lata; trifoliolata foliolis obovatis, apice truncatis et brevissime apiculatis, mucronato-acutis, centralia usque ad 1 cm longe petiolulata, petiolulo supra sulcato suffulta, lateralia ±1 cm minora, sessilia, basi valde obliqua; nervo medio supra in sulco prominulo, subtus carinato, lateralibus utroque latere 6—8, basalibus leviter remotis et apicem versus arcuatis, supra levissime impressis et obsoletis, reticulo nullo, subtus tenuiter prominulis et reticulato-conjunctis; lamina supra nitida, minute rugulosa, subtus minute foveolata, lepidibus supra nullis, subtus in foveolis reticuli obsoletis vel absentibus, margine minute crenulata vel integra, utrinque glabra, coriacea.

Inflorescentia terminalis 1-flora. Pedunculus usque ad 1,5 cm longus, sparse lepidotus, plerumque cernuus, ferrugineo-lepidotus. Calyx 3-lobatus, 2-labiatus, 8—12 mm longus, ferrugineo-lepidotus. Corolla alba, 4—5 cm longa e tubo angusto superne abrupte dilatata. Capsula 14—16 cm longa, apice acuminata, sparse cinereo-lepidota; semina bialata, 5 mm longa et 8—10 mm lata, cum alis 2,5—3 cm lata.

Holotypus: 27843 HAC; Cuba Occidentalis; Prov. Pinar del Rio; Sierra del Rosario, Loma El Taburete, entre Cayajabos y Las Terrazas, in silvis apertis semideciduis, solo calcareo. Leg.: A. BORHIDI et E. DEL-RISCO, 4. Jul. 1974. Isotypi: HAC, BP.

Specimina examinata: Ibidem leg. E. DEL-RISCO HAC 26785.

Obs.: *Tabebuiae lepidophyllae* (A. Rich.) Greenm. affinis, quae a specie nostra foliis oblongo-obovatis, basi attenuatis vel obtusis, subtus dense lepidotis, margine recurvo, calyce majore, 5-lobulata, lobis acutis, corolla rosea, capsula breviore differt.

Obs. II.: Hanc speciem Ing. ENRIQUE DEL-RISCO, geobotanico cubano, in phytocoenologia silvarum studiosissimo dedicavi.

Fig. 6. Rama florescente de la *Tabebuia del-riscoi* Borhidi en la localidad clásica (Foto: A. Borhidi)

Tabebuia × rosariensis Borhidi **hybr. n.**
(*T. del-riscoi* Borhidi × *T. angustata* Britt.)

Arbor parva, usque ad 4—5 m alta. Ramuli hornotini lutescentes, striati, minute luteo- vel brunneo-lepidoti, veteriores teretes, albescentes, cicatricibus magnis ovalibusque obsiti. Folia 3-foliolata, 3,5—6 cm longe petiolata, petiolis superne applanatis, striatis et sparse lepidotis suffulta, foliola subaequalia, centrale 1—2 cm longe petiolulata, oblongo-ovata vel oblongo-elliptica, basi obtusa vel rotundata, apice acuminata et acuta, 7—12 cm longa et 3—5 cm lata, lateralia subaequimagna, basi breviter obliqua, 3—6 cm longe petiolulata, petiolulis supra sulcatis suffulta; nervo medio utrinque prominenti, lateralibus utroque latere 7—10 supra obsolete prominulis et vix conspicue reticulatis, subtus prominentibus et tenuiter reticulatis; lamina supra nitida, non lepidota, subtus opaca, sparsissime vel non lepidota, margine integra, leviter undulata, chartacea. Cetera ignota.

Holotypus: Cuba Occidentalis; Prov. Pinar del Rio; Sierra del Rosario, in declivibus meridionalibus montis Loma El Taburete, locis apertis, solo calcareo inter parentes, alt. approx. 250—300 m. s. m. Leg.: A. Borhidi et E. Del-Risco 4. jul. 1974. HAC 28022. Isotypi: HAC, BP.

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DIE VEGETATIONSKARTE VON KUBA

Von

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(Eingegangen: 1. Mai, 1979)

Authors realized maps of precipitation and bioclimatic regions of Cuba. 5 climatic types including 12 climatic subtypes are represented: — semidesertic climat (with 1 subtype), — tropical climat with dry winter and 1 dry period (with 3 subtypes), — bixeric tropical climat with a longer dry winter and a shorter dry period in summer (with 4 subtypes) — humid tropical climat without dry season (two subtypes), — humid subtropical/higher mountain climat without dry period (with 2 subtypes). 9 climax vegetation zones are conditioned by the distribution of the mentioned climatic types: 1. Zone of semidesertic cactus-scrubs; 2. Zone of semideciduous/evergreen scrub-woodland; 3. Zone of tropical deciduous forests; 4. Zone of semideciduous tropical forests; 5. Zone of seasonal evergreen tropical forests; 6. Zone of submontane tropical rain forests; 7. Zone of montane rain forests; 8. Zone of elfin forests; 9. Zone of montane evergreen scrubs and thickets. A high variability of the vegetation is conditioned by the interaction of the climats and the many types of geologic substrats and soils. The map of the potential natural vegetation types (including the azonal coastal vegetation) and 34 higher vegetation units included. Authors discuss the effect of serpentine rocks and soils on the evolution of the flora and vegetation, in tropical conditions. Authors deal with the problem of origin of the Cuban savannas presenting the original, secondary and anthropic grassland areas in a separate map and further the areas which the natural vegetation is inclined to be transformed to savannas in a short time in.

Analyzing the origin of the Cuban flora the important role of endemic genera and species (over 50%) in the flora is emphasized. Authors suggest in the evolution of the Cuban flora 3 main periods can be distinguished: *a)* plate-phase, the epoch of the independent Antillean-plate, which the ancient relicts and taxa of afro-madagascarian and pacific descendence (*Mycrocycas*, *Cneorum*, *Dracaena*, *Colpothrinax*) survived from; *b)* landbridge-phase, the epoch of continental land-bridges (Honduras, Yucatan) between Central America and the Greater Antilles, as the main epoch of the invasion of the neotropic flora to the West Indies; *c)* isolation-phase, epoch of the separation of the islands from the continent and from each other, characterized by the specialization of the floras and the evolution of the endemic taxa.

Geographische Verhältnisse

In der westindischen Inselwelt ist Kuba das größte und wirtschaftlich das wichtigste Land. Es umfaßt ein Gebiet von 110 922 km², davon ist die Insel-Kuba 105 007 km², die Insel-Pinos 2200 km² und die mehr als tausend kleinen umliegenden Inseln und Klippen machen 3715 km² aus.

Hier erheben sich 4 größere Gebirgsmassive. In West-Kuba das Guaniguanico-Massiv das im Gipfel von Pan de Guajaibón 692 m erreicht, und in das Rosario-Gebirge und in das Organos-Gebirge geteilt ist. Letzteres ist aus recht hartem, blauen Jura-Kalkstein aufgebaut,

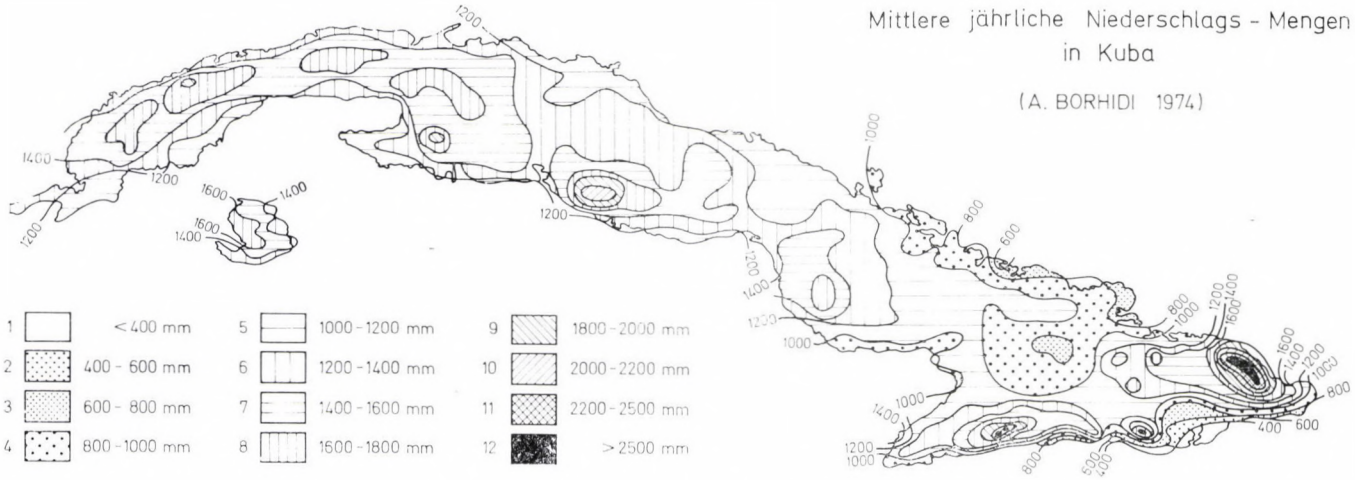


Abb. 1. Mittlere jährliche Niederschlagsmengen in Kuba. (Nach BORHIDI, 1974)

und wegen seiner bizarren Kegelberge hält man es mit Recht für eines der schönsten Karstgebirge der Tropen.

In Mittel-Kuba befindet sich das Guamuhaya-Massiv, dessen Aufbau geologisch sehr verschiedenartig ist. Es ist in zwei Gebirge geteilt: das Escambray Gebirge über Trinidad erreicht eine Höhe von 1156 m (Pico San Juan), das Sancti-Spiritus Gebirge nur 883 m (Loma de Banao).

Die höchsten und mächtigsten Gebirgen finden wir im Osten von Kuba, — in der Provinz Oriente (jetzt in 5 Verwaltungsprovinzen geteilt). Die Sierra Maestra ist ein Kettengebirge von einer Länge von 250 km und einer Breite von 30 km. Sein höchster Gipfel, der Pico Turquino erreicht die 1974 m, der gleichzeitig der höchste Punkt von ganzen Kuba ist. Das von hier nord-östlich gelegene recht verwickelte Sagua—Baracoa Massiv ist in etwa 10—12 kleinere Gebirge gegliedert. Der Höhepunkt ist der Gipfel des Kristal-Gebirges (Pico Cristal), in einer Höhe von 1325 m. Diese orographisch und geologisch außerordentlich abwechslungsreiches Bergland ist für die Flora von Kuba und ferner der gesamten Antillen das wichtigste Entwicklungszentrum.

Klimaverhältnisse

Trotz alledem daß Kuba unmittelbar südlich vom Tropischem Kanzer, zwischen der 19. und 23. Breiten gelegen ist, ist ihr Klima viel wärmer und tropischer, beeinflußt von den warmen Meeresströmen, die ihre Küsten umfließen, als das Klima der auf ähnlichen geographischen Breiten liegenden Kontinenten.

Die mittlere Jahrestemperatur wechselt zwischen 24,5 und 28 °C, die Mitteltemperatur des kältesten Monats ist über 19 °C. In der Richtung von Nord-Westen nach Süd-Osten nehmen die Temperatur-Mittelwerte zu, gleichzeitig nimmt aber die mittlere Tagestemperaturschwankung ab. Im Tiefland ist die gemessene niedrigste Temperatur +3 °C, die gemessene höchste Temperatur 40 °C. Frost oder Schnee wird in Kuba selbst in den höchsten Bergen nie beobachtet.

Der vertikale Temperaturgradient ist in den südlichen, küstennahen Gebirgen wesentlich höher als in den nördlichen; in den Escambray- und Maestra-Gebirgen beträgt 0,9 Grad/100 Meter, und in dem Sagua-Baracoa Massiv nur 0,66 Grad/100 Meter.

Die jährlichen Mittelwerte der relativen Luftfeuchtigkeit wechseln zwischen 74 und 80%; die niedrigsten Mittelwerte wurden in Guantánamo, am Rande der Halbwüstenzone gemessen 68%, in der Zone der Bergregenwälder hingegen wurden über 90% beobachtet.

In Kuba wechselt der mittlere Jahresniederschlag zwischen 300 und 3000 mm. Diesbezüglich stoßen wir die erregendsten Kontraste in Oriente, wo das regenreichste Gebiet, die Umgebung des Moa-Toa-Baracoa Gebirges ist, mit einem mittleren Jahresniederschlag von 2 bis 3000 mm, stellenweise auch bis 5000 mm. Etwa 20 km südwärts finden wir schon eine Halbwüstenvegetation bei einem jährlichen Niederschlag von 300 bis 500 mm. In dem kubanischen Flachland hingegen ist der mittlere Jahresniederschlag übrigens zwischen 1000 bis 1600 mm (Abb. 1).

Klimatypen und Vegetation

Unsere Aufgabe war die Karte der potentiellen natürlichen Vegetation von Kuba in einem Maßstab von 1 : 1 000 000 zu verfertigen. Dazu war nicht nur das gründliche Studium und die Charakterisierung der Vegetation not-

wendig, sondern die Bestimmung und Kartierung der Bioklimatypen, weiterhin die Festsetzung der Korrelationsenge von den Bioklima- und Vegetationstypen um auf die ursprüngliche zonale Vegetation der sehr verbreiteten Kulturgelände schließen zu können.

Die folgenden 12 Klimatypen und Varianten wurden festgestellt und kartiert (Abb. 2. S. auf Beilage):

A) 2c

Halbwüstenklima mit 300 bis 600 mm jährlicher Niederschlagsmenge in unregelmäßiger Verteilung und mit einer 9 bis 11 monatigen Dürrezeit. Dieser Klimatyp kommt an der Südostküste von Oriente vor. Die zonale Vegetation ist eine kakteenreiche Dornbusch-Halbwüste auf lockeren sandigen oder steinigen Böden und eine agavenreiche Dornbusch-Halbwüste auf den felsigen Kalk-Terrassen. Auf tiefgründigen, feinkörnigen Schwemmböden wurden originelle Graßlände von Halbkultur- und Kulturweiden vertreten.

B) 4 Th

Zenitales Sommerregenklima mit einer Trockenzeit. Die mittleren Jahresniederschläge betragen eine Wassermenge von 750 bis 800 mm. In Kuba finden wir die folgenden Varianten:

a) 4b Trockene Variante mit einer 5—6 monatigen Trockenzeit
b) 4c Mäßig trockene Variante mit einer 3—4 monatigen Trockenzeit
c) 4d Subhumide Variante mit einer 1—2 monatigen Trockenzeit.

Dieser Klimatyp ist in dem Flachland und in den Gebirgsregionen von West- und Mittel-Kuba, weiterhin in Oriente, am Nordabhang und bei den Vorgebirgen der Sierra Maestra zu finden, bis zu einer Höhe von 800 m.

Die zonale Vegetation ist in der trockenen Variante meistens durch halbimmergrünen Sommerregenwald, in der mäßig trockenen Variante durch halbimmergrünen Sommerregenwald und immergrünen Saisonwald vertreten, in dem Bereich der subhumiden Variante dominieren immergrüne Saisonwälder und submontane Regenwälder.

C) 5 Th

Zenitales Sommerregenklima mit zwei Trockenzeiten. Dieser Klimatyp ist von einer längeren Winter- und einer kürzeren Hochsommer-Trockenperiode charakterisiert. Nach der Dauer der Trockenperioden unterscheiden wir vier Varianten:

a) 5a Sehr trockene Variante mit Trockenzeiten von insgesamt 7—8 Monaten
b) 5b Trockene Variante mit Trockenzeiten von 5—6 Monaten

c) 5c Mäßig trockene Variante mit Trockenzeiten von 3—4 Monaten
d) 5d Subhumide Variante mit Trockenzeiten von 1—2 Monaten

Dieser Klimatyp herrscht vorwiegend an den Nordküsten von Mittel- und Ost-Kuba, und in der Cauto-Ebene, an den Südküsten nur mesoklimatisch. Die sclerophyllen Vegetationstypen haben sich in größerem Maße an diese doppelte Trockenperiode angepaßt, als die laubabwerfenden Wälder.

In der sehr trockenen Variante finden wir vorherrschend halbimmergrüne und immergrüne Dornbuschwälder, in der trockenen Variante Dornbuschwälder und kleinblättrige, halbimmergrüne Trockenwälder, in der mäßig trockenen Variante sind die halbimmergrünen tropischen Wälder, die immergrünen Trockenwälder und die immergrünen Saisonwälder die zonalen Vegetationstypen, während in der subhumiden Variante immergrüne Saisonwälder und meistens submontane Regenwälder zu finden sind.

D) 6a

Immerfeuchtes equatoriales Regenwaldklima ohne Trockenzeit mit einer jährlichen Mitteltemperatur über 20 °C; die mittleren Jahresniederschläge sind zwischen 1600—5000 mm. Dieser Klimatyp entfaltet sich in Nord-Ost-Oriente in den Moa-Toa-Baracoa Gebirgen, und in kleineren Gebieten West-Kubas, im Ostgebiet des Rosario-Gebirges. Die zonale Vegetation ist ein submontaner Regenwald.

E) 6b

Immerfeuchtes subequatoriales Bergregenwaldklima ohne Trockenzeit und mit einer jährlichen Mitteltemperatur zwischen 15 und 20 °C. Dieser Klimatyp herrscht in den Gebirgen in einer Höhe von 600—1600 m, die mittleren jährlichen Jahresniederschläge sind zwischen 1400—2200 mm, in recht gleichmäßiger Verteilung. Die zonale Vegetation besteht aus tropischen Bergregenwäldern.

F) 7a

Immerfeuchtes Nebelwaldklima der Hochgebirge ohne Trockenzeit mit einer mittleren Jahresluftfeuchtigkeit über 90%, und mit der jährlichen Mitteltemperatur zwischen 10—15 °C. Dieser Klimatyp kommt in Kuba nur im zentralen Teil der Sierra Maestra in der Höhe von 1400—1800 m vor. Die zonale Vegetation ist hier: Bergregenwälder und Nebelwälder.

G) 7b

Immerfeuchtes Klima der subalpinen Stufe ohne Trockenzeit, mit einer jährlichen Mitteltemperatur zwischen 0—10 °C. Dieser Klimatyp kommt in

Kuba ausschließlich in der Turquino-Gruppe über 1800 m vor. Die Jahresniederschläge sind über 2500 mm. Immergrüne subalpine Buschwälder bilden die zonale Vegetation.

Die Vegetationszonen von Kuba

All diese Angaben in Betracht genommen, können wir feststellen, daß in Kuba neun klimatisch bedingte zonale Vegetationstypen zu unterscheiden sind:

1. Zone der Dornbusch-Halbwüsten
2. Zone der halbimmergrünen und immergrünen Dornbuschwälder
3. Zone der Sommerregenwälder bzw. kleinblättrigen halbimmergrünen Wälder
4. Zone der halbimmergrünen Wälder
5. Zone der immergrünen Saisonwälder
6. Zone der submontanen Regenwälder
7. Zone der Montanen oder Bergregenwälder
8. Zone der Nebelwälder
9. Zone der subalpinen immergrünen Buschwälder.

Boden und Vegetation

Die Mannigfaltigkeit der Vegetation innerhalb der einzelnen Zonen wird in allerersten Reihe von der Verteilung der edaphischen Faktoren kontrolliert. In Kuba finden wir vielerlei Grundgestein, und eine große edaphische Varietät. Auf Grund morphologischer Merkmale unterschiedeten und kartierten Bennett und Allison (1926) etwa 80 Bodentypen; die neueren genetischen Bodenklassifikationen (z. B. Hernandez et al., 1975) unterscheiden 20 Bodentypengruppen und innerhalb deren mehr als 100 genetische Bodentypen. Dementsprechend finden wir in Kuba eine ganze Anzahl edaphisch bedingter Vegetationstypen und Pflanzengesellschaften, z. B. die verschiedenen tropischen Föhrenwälder, Karstwälder, alle Typen der Serpentin-Vegetation, Ufer- und Strandvegetation, wechselfeuchte Savannen usw.

Eine erwähnungswerte Tatsache ist, daß die Abgrenzung der zonalen Pflanzengesellschaften — wie überall in dem tropischen Gürtel — oft eine schwere Aufgabe bedeutet, die Grenzen edaphisch bedingter Pflanzengesellschaften sind aber meistens sehr scharf und ebenso gut zu erkennen, wie die in der Vegetation der gemäßigten Zone. Dafür dienen als gutes Beispiel die Pflanzengesellschaften der Serpentinböden, die wir eingehend studierten, um den ökologischen Hintergrund des Serpentineffektes zu erkennen (Borhidi, 1975).

Serpentineffekt

Die Angaben der diesbezüglichen zahlreichen Publikationen sind widersprüchlich (KRAUSE, 1958 und die dort zitierte Literatur, PROCTOR, 1971a, b, PROCTOR and WOODELL, 1971). Einige Autoren halten im ökologischen Kontroll die Wirkung von 9 verschiedenen Serpentin-Faktoren für entscheidend. Laut KRAUSE (1958) wirken diese Faktoren gemeinsam in einer sogenannten Serpentinkombination. Wir stellen hingegen fest, daß in jedem einzelnen Fall die Wirkung eines einzigen Faktors entscheidend sei. Dieser Kontrollfaktor ist von der chemischen Zusammensetzung des Serpentins und von dem aktuellen Stand des Bodens im Verwitterungsprozesse abhängig. In den Tropen können wir drei Hauptphasen der Serpentin-Florenentwicklung unterscheiden, die in den verschiedenen Phasen der Verwitterungsprozesse von 3 verschiedenen Serpentin-Faktoren beeinflußt werden (BORHIDI, 1975).

Diese sind wie folgt:

a) *niedriger Calcium-Magnesium Index, beziehungsweise Wirkung einer Magnesium-Überlastung auf die Serpentin-Skelettböden*

b) *Wirkung der Auslaugung durch vollständiges Verschwinden von Calcium und Magnesium und parallel mit einer giftigen Anhäufung des Aluminiums in den latosolartigen Böden*

c) *Schwermetall-Vergiftung in den alten Latosol-Böden*

Da in jeder einzelnen Phase die ökologischen Wirkungskomponente der vorigen Periode teilweise oder ganz verschwinden, erzwingt jede einzelne Phase der Bodenentwicklung eine völlig neue Anpassung der Flora. Infolge dessen verdreifacht sich am Schluß der dritte Periode die Flora eines Serpentingebietes. Eine kurze Statistik soll dies veranschaulichen:

Aus den 6140 Blütenpflanzen-Arten von Kuba sind 51,3% endemisch. Ein Drittel der endemischen Arten, 920 Arten, sind ausschließlich Serpentin-Endemiten, die auf Serpentinareas leben, die nur 7% des gesamten Gebietes der Insel ausmachen. (Tabelle 1 und vgl. auch Tabelle 3.)

Tabelle 1

Endemische Sippen der Flora von Kuba auf Serpentin-Gebieten verschiedenen Alters

	Oberfläche		Serpentin-Endemiten			
			Gattungen		Arten	
	km²	%	Zahl	%	Zahl	%
Alte Serpentin-Gebiete	4800	64	21	91,30	750	81,52
Junge Serpentin-Gebiete	2700	36	—	—	128	14,08
Gemeinsame Sippen	—	—	2	8,70	42	4,40
Insgesamt	7500	100	23	100,00	920	100,00

Das Serpentin-Gestein übt ebenfalls eine bedeutende Wirkung auf die Entwicklung der Vegetation. Starke Xeromorphie charakterisiert die Serpentin-Vegetation, da der Boden physiologisch trocken ist. Diese physiologische Dürre ist in Kuba mit einem jährlichen Niederschlagsdefizit von 500—600 mm equivalent (BORHIDI, 1973, 1976). Eine nicht effektive Raumausnützung, die Verringerung der Vegetationsschichten, Hinabsenkung der photosynthetisch aktiven Oberfläche in den Gesellschaften und abnehmende Produktivität kennzeichnen die Struktur und Produktion der Serpentin-Vegetation (vgl. auch WHITTAKER, 1954). In der Serpentin-Gesellschaften der Tropen werden die Epiphyten und die Baumfarne zurückgedrängt, andere Lebensformen hingegen, wie die Sträucher und Halbsträucher, haben eine wichtige Rolle. Unter den Bäumen und Sträucher wurden die micro- und nanophyllen Arten zu Herrschaft kommen.

Der Serpentin beeinflußt die vertikale Stufenfolge der Vegetation ebenfalls, indem sich die entsprechende Vegetationszonen in den Serpentingebirgen in niedriger Höhe — mit xerophyllen Entwicklungsformen entwickeln, einige hyperhumide Vegetationsstufen hingegen völlig fehlen (z. B. Nebelwälder) (s. Tabelle 2).

Tabelle 2

Stufenfolge der Vegetationszonen in einem Granit- und in einem Serpentin-Gebirge in Kuba

Sierra Maestra (Granit)	*Sierra de Moa* (Serpentin)
Immergrüner Saisonwald 100—400 m	—
Submontaner Regenwald 400—800 m	Submontaner Regenwald 100—400 m
Feuchter montaner Regenwald 800—1600 m	Halbtrockener montaner Regenwald 400—900 m
Montane Nebelwälder 1600—1900 m	—
Immergrüne subalpine Buschwälder 1900—2000 m	Halbtrockene immergrüne montane Buschwälder, 900—1100 m

Die Vegetationstypen

Im Laufe der Vegetationskartierung wurden insgesamt 34 Vegetationstypen unterschieden und kartiert (S. Abb. 20 auf Rückseite der Beilage). Über eine detaillierte Artenzusammensetzung der Vegetationseinheiten von Kuba s. BORHIDI, MUÑIZ und DEL-RISCO, 1979.

Submontane Regenwälder

Die tropischen Regenwälder bilden die erste Gruppe, wohin die submontanen und montanen Regenwälder und auch die Nebelwälder eingereiht werden. Die submontanen Regenwälder leben in den Tälern der Toa, Jaguani

und Duaba Flüsse (NO-Kuba) meistens auf Gabbro-Gestein, auf gelbem bzw. rotgelbem Bergboden, bei einem jährlich mehr als 2000—2500 mm Niederschlag. Sie haben 3 Laubkronenschichte; in der oberen herrscht die *Carapa guianensis*, in der zweiten sind *Guarea guidonia*, *Cupania americana*, *Calophyllum utile* usw. zu finden, unter anderem der Balse (*Ochroma pyramidalis*) und verschiedene Würgerbäume (*Clusia rosea*, *Ficus wrightii*), in der dritten finden wir oft Palmen und Baumfarne. Ein charakteristisches Element für den Unterwuchs ist eine Musaceen-Art, *Heliconia caribaea*.

Diese Wälder sind an Lianen arm, hingegen können wir zwei üppigen Epiphyten-Schichten unterscheiden, eine aus Orchideen, Bromeliaceen und Dicotyledonen (*Hillia parasitica*, *H. tetrandra*, *Columnea tincta*, *Psychotria guadelupensis*) bestehende Sonnen-Epiphytenschicht und eine aus Farne, Zwergorchideen und Moose bestehende Schatten-Epiphytenschicht.

Montane Regenwälder

Die humiden Bergregenwälder entstehen in einer Höhe von 800—1600 m in den Sierra Maestra, Escambray und Puriales-Gebirgen. Sie sind 20—25 m hohe Wälder mit zwei Laubkronenschichten. Die obere ist fest geschlossen, bestehend meist aus *Magnolia cubensis*, *Cyrilla antillana*, *Ocotea*- und *Laplacea*-Arten, in der unteren Schicht spielen die Baumfarnen eine wichtige

Abb. 3. Baumfarnreicher montaner Regenwald auf dem Gipfel Pico Turquino, in einer Höhe von 1700 m. (Foto: BORHIDI)

Rolle (Abb. 3). Hier finden wir ebenfalls eine doppelte Epiphyten-Schicht, in der unteren erscheinen massenweise die Hautfarnen und in der Strauchschicht die auf Blättern wachsenden epiphyllen Moose.

In den Serpentin-Gebirgen wird diese Zone in der Höhe von 400—900 m durch halbtrockene Bergregenwälder ersetzt. Diese Wälder werden durch kleinblättrige sclerophylle Bäume mit lückenhafter oberen Laubkronenschicht, durch *Byrsonima coriacea* und *B. orientensis, Sloanea curatellifolia, Calophyllum utile, Podocarpus ekmanii, Hyeronima nipensis* gekennzeichnet. In der unteren Laubkronenschicht fehlen meistens die Baumfarnen, desto häufiger begegnen wir den *Bactris cubensis* Palmen. Reich ist die Strauchschicht und besteht fast ausschließlich aus endemischen Arten, hauptsächlich aus Myrtaceen, Melastomataceen, Ericaceen, Rubiaceen und Asteraceen. Hier gibt es nur eine aus Zwergorchideen bestehende Sonnenepiphytenschicht, die Schattenepiphyten und die epiphyllen Moose fehlen fast völlig.

Nebelwälder

Nebelwälder sind nur in der montanen Region des Maestra-Gebirges, in der Höhe von 1600—1900 m, und an den Gipfeln der Turquino- und Bayamesa-Gruppe zu finden. Besitzen eine einzige Laubkronenschicht von 8—12 m, die aus knorrigen Bäumen besteht, wie *Myrsine microphylla, Nectandra reticularis, Weinmannia pinnata, Torralbasia domingensis, Cyrilla antillana,* doch sind auch viele Baumfarne beigemischt. Die Äste und Stämme sind von Moospölstern bedeckt, in denen Hautfarne (*Hymenophyllaceae*) und Zwergorchideen (*Lepanthes, Stelis, Microlepanthes* und *Pleurothallis*-Arten) in großer Fülle gedeihen (Abb. 4). Die dichte Strauchschicht ist von Farnlianen zu einem undurchdringlichen Dickicht umschlungen und in der Krautschicht formen Lycopodiaceen und *Selaginella*-Arten einen leuchtend grünen Teppich. Die Moose hängen oft als lange Vorhänge von den Ästen herunter, und sind mit Wassertröpfchen bedeckt.

In den Serpentin-Gebirgen werden die Nebelwälder in der Höhe von 700—1100 m von halbtrockenen immergrünen Bergbuschwäldern ersetzt. Diese Formation besteht aus einer 4—6 m hohen Strauchschicht mit 7—10 m hohen herausragenden Bäumchen. Mikro- und nanophylle Sträucher sind hier herrschend, wie *Myrica shaferi, Ilex-, Buxus-, Clusia-, Cyrilla-, Lyonia-* und *Laplacea*-Arten. Die Zahl der Epiphyten ist gering, an den Ästen fehlt die Moosschicht, demgegenüber gibt es hier viel Liane (z. B. *Arthrostylidium, Chusquea, Feddea, Morinda*), und am Boden ist die massenhafte Erscheinung von den *Leucobryum-* und *Sphagnum*-Arten recht häufig.

Immergrüne Saisonwälder

In den Ebenen und Mittelgebirgen von Kuba waren ursprünglich die immergrünen Saisonwälder und die halbimmergrünen Wälder die herrschen-

Abb. 4. Montaner Nebelbuschwald reich an Moosen, Farnen und epiphytischen Zwergorchideen, auf dem Gipfel Pico Real, in einer Höhe von 1900 m. (Foto: BORHIDI)

den. Die besten Zuckerrohrpflanzungen wachsen auf den latosolartigen Matanzas-Rotböden, die die ursprüngliche Standorte der ehemaligen immergrünen Flachland-Saisonwälder waren. Infolge der Expansion der Landwirtschaft sind diese Wälder fast spurlos verschwinden. Auf Grund einiger anthropisch wenig beeinflußten Reliktbestände konnten wir den Struktur und die Artenzusammensetzung dieser Wälder rekonstruieren. Sie besaßen eine etwa 20—25 m hohe zweischichtige Laubkrone mit herausragenden laubabwerfenden Riesenbäumen (*Ceiba pentandra, Cedrela mexicana*). In der oberen Laubkronenschicht sind *Roystonea regia, Guazuma ulmifolia, Mastichodendron foetidissimum, Luehea speciosa, Cordia collococca* und *Cordia gerascanthus, Andira inermis* und microphylle Leguminosen-Bäume, wie *Pithecellobium cubense* und *Samanea saman,* kennzeichnend. An den hohen Bäumen sind die Äste oft massenhaft von xero-epiphytischen Tillandsien bedeckt.

Im Rosario-Gebirge, im Escambray-Gebirge und in der Sierra Maestra bis zu 800 Metern ist das Gelände von submontanen, immergrünen Saisonwälder bewachsen. Für sie bezeichnend ist, daß die im Flachland verbreiteten megathermen Baumarten (wie *Ceiba, Guazuma, Samanea*) hier völlig fehlen. In West- und Mittel-Kuba wird diese Formation durch die konstante Anwesenheit von *Matayba oppositifolia, Pseudolmedia spuria, Zanthoxylum martinicense, Sloanea amygdalina, Margaritaria nobilis, Hibiscus elatus* charakterisiert, während in Oriente *Dipholis jubilla, Oxandra laurifolia, Zizyphus rhodoxylon, Chrysophyllum argenteum* ihre Kennarten sind. Ebenfalls bezeichnend sind die epiphyllen Flechten und die terrestrischen Farne und Orchideen in der Krautschicht.

Halbimmergrüne Sommerregenwälder

Die halbimmergrünen Sommerregenwälder bedeuten für West- und Mittel-Kuba den am häufigsten vorkommenden Vegetationstyp, dessen Lebensrhythmik zum wechselfeuchten Gepräge des Sommerregen-Klimas am besten paßt. Sie entwickeln sich hauptsächlich auf flachgründigen latosolartigen Rotböden und tropischer Braunerde. Sie haben zwei Laubkronenschichte, die obere ist 18 bis 25 Meter hoch, und die laubabwerfenden Bäume übersteigten die Hälfte der Gesamtdeckung nicht. Die gewöhnlichsten laubabwerfenden Arten sind: *Bursera simaruba, Cedrela mexicana, Swietenia mahagoni, Catalpa punctata, Zuelania guidonia, Roystonea regia* (Abb. 5), *Pithecellobium lentiscifolium* usw. Die untere Laubkronenschicht ist reich an Arten, und enthält keine trockenkahle Elemente. Die Zahl der Epiphyten ist gering, hingegen ist die Lianenschicht recht entwickelt, und besteht aus mehr als 30 Arten. Die Krautschicht ist selten oder fehlt vollständig.

In den östlichen Flachgeländern von Mittel-Kuba, in den trockenen und sehr trockenen Varianten des Sommerregen-Klimas, besonders auf Sandböden entwickeln sich kleinblättrige halbimmergrüne Trockenwälder. Ihre Kronenschicht ist niedriger als die der halbimmergrünen Sommerwälder, die durch zahlreiche laubabwerfende Leguminosen-Bäume charakterisiert sind, und hat in der Strauchschicht viele Dornbüsche.

Mangrove- und Sumpfwälder

In Kuba haben, nebst der klimazonalen Waldgesellschaften die verschiedenen edaphisch bedingten Wälder eine bedeutende Rolle. Hierher gehören die immergrünen Mangrove-Wälder, die in Kubaartenarm sind, und insgesamt aus 4 Baumarten bestehen. Die äußerste Zone bildet die *Rhizophora mangle* mit Stelzwurzeln, die darauf folgende Zone die *Avicennia germinans* mit dünnen aus dem Boden herauswachsenden Atemwurzeln. In der zeitweise über-

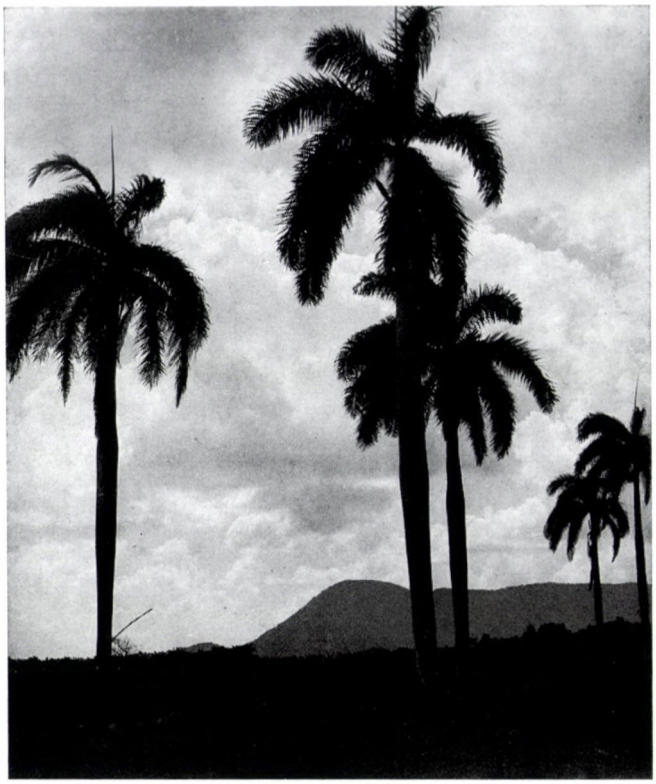


Abb. 5. Frische Rodung im Bereich der halbimmergrünen Wälder mit Königspalmen (*Roystonea regia*) als Resten des ehemaligen Naturwaldes, am Fuß der Sierra de Cubitas (Camagüey-Provinz). (Foto: BORHIDI)

schwemmten Zone herrscht die *Laguncularia racemosa*, doch die innerste Zone wird mit zunehmender Salzkonzentration von den Beständen der *Conocarpus erecta* besetzt. An diese Zone schliessen sich oft landeinwärts die Salzfluren von *Batis maritima* an, wo die Salzanhäufung am größten ist.

Im Gegensatz zur immergrünen Mangrove sind die mit Süßwasser überschwemmte Sumpfwälder trockenkahl. Diese Wälder besetzen das größte Gebiet auf der Halbinsel Zapata, ihr herrschender Baum ist die *Bucida palustris*. Sie haben eine artenarme, aber üppige Strauchschicht und eine hohe Krautschicht aus *Cladium jamaicense*.

Tropische Karstwälder

Von den edaphisch bedingten Pflanzengesellschaften sind die tropischen Karstwälder besonders interessant. Diese Gesellschaften sind auf den Orgel- und Kegelkarstbergen zu finden, die eine ganz eigene Form haben, deren turm-

Abb. 6. Tropische Karst-Kegelberge in der Sierra de los Organos (West-Kuba), bedeckt mit Karstbuschwäldern. Im Vordergrund: *Pinus caribaea* auf San-Cayetano-Sandstein. (Foto: BORHIDI)

artige Formen und senkrechte Felsenwände die Erosion der Jahrmillionen aus den weicheren Gesteinen — wie es der San-Cayetano-Sandstein in West-Kuba ist — herausmodellierte (Abb. 6). An diesen Mogoten genannten Kegelkarstbergen finden wir sechs verschiedene Pflanzenformationen in mosaikartiger Verbreitung. An den sonnigen Felsenwänden finden wir eine Agaven- und sukkulentenreiche offene Felsenvegetation, an steilen, schattigen, fast senkrechten Wänden hingegen hat sich eine Gesneriaceen- und farnenreiche Felsengesellschaft ausgebildet. Auf den Kalkrücken entwickelt sich ein trockenkahler offener Karstbuschwald mit Bombacaceen und Palmen von flaschenförmigen Stämmen für die Wasserspeicherung (wie *Bombacopsis cubensis* und *Gaussia princeps*), mit einer sehr artenreichen microphyllen Strauchschicht, und mit einem außerordentlichen Reichtum von Lianen und lianartigen Kakteen. Auf dem kuppelförmigen Gipfel finden wir dagegen ein Bromeliaceenreiches immergrünes Karstgebüsch, mit der Dominanz von *Vriesea dissitiflora* und *Cerato-*

pyxis verbenacea (eine endemische Gattung der Rubiaceen). Am Fuße der Felswände entstand ein halbimmergrüner Haldenwald, in den Dolinen dagegen finden wir einen feuchten immergrünen Schluchtwald. Außer der für typisch bekannten west-kubanischen Mogotenwälder können wir noch 3 geographische Varianten der Karstvegetation von Kuba unterscheiden, und zwar die mittel-kubanische, die ostkubanische und die montane Mogotenvegetation.

Tropische Nadelwälder

Die tropischen Nadelwälder sind eine sehr interessante Erscheinung in der Vegetation von Kuba; ungewohnterweise leben sie nicht in den höheren Gebirgen, sondern meistens in der Ebene oder im Hügelland und Mittelgebirge, auf extrem saueren und nährstoffarmen Böden. In West-Kuba sind das die *Pinus tropicalis* Kiefernwälder auf weißem Quarz-Sandboden mit *Acoelorraphe*-Palmen und mit den berühmten endemischen Dickbauch-Palmen der *Colpothrinax wrightii*.

Auf der San Cayetano-Formation hat sich ein immergrüner Eichen-Kiefernwald mit *Pinus tropicalis* und *caribaea* ausgebildet sich vergesellschaftend mit der kubanischen Eiche (*Quercus oleoides* ssp. *sagraeana*). Das Vorkommen der Nadelwälder ist am häufigsten auf den uralten Latosol-Böden der Serpentin-

Abb. 7. Tropischer Kieferwald auf Serpentin-Latosol Böden, mit der Dominanz von *Pinus caribaea* ssp. *caribaea*, in der Sierra de Cajalbana (Pinar del Rio Provinz) in einer Höhe von 300 m. (Foto: BORHIDI)

Gebirgen, die extrem ausgelaugt, fast sterile Eisen-Erzböden sind mit einer sehr großen Anhäufung von Ferrioxiden und Schwermetallen. Diese Latosol-Kieferwälder (Abb. 7), die als Paraklimax-Gesellschaften zu betrachten sind, haben eine artenreiche immergrüne Strauchschicht mit sehr vielen endemischen Sträuchern und eine üppig gebildete Krautschicht vieler Gramineen und Cyperaceen. In der Kronenschicht herrscht in West-Kuba die monodominante *Pinus caribaea*, und in Ost-Kuba die *Pinus cubensis*.

Wahrlich ganz eigenartig sind die in Maestra-Gebirge im der Bergregenwaldstufe, in den extrem sauren Sandstein- und Andesittuffe-Böden vorkommenden *Gleichenia*- und Baumfarnreiche Bergkiefernwälder, die in der Höhe von 800 bis 1600 Metern von *Pinus maestrensis* gebildet sind.

Trockenbuschwälder

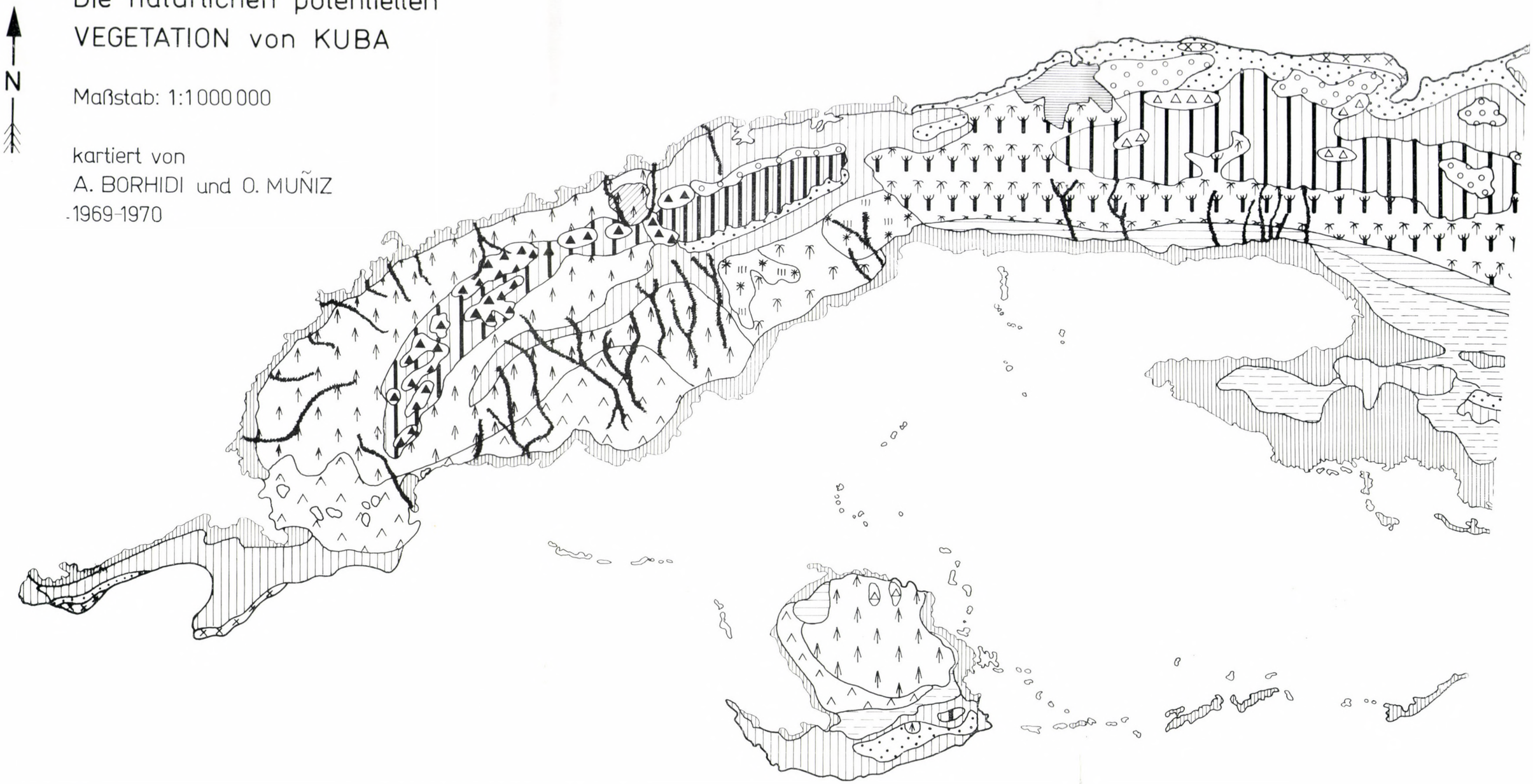
In der Reihe der edaphisch bedingten Gesellschaften bedecken die Serpentin-Buschwälder (Abb. 8) und die Kalk-Küstenbuschwälder ein erhebliches Gebiet. Die vorigen stehen in unmittelbaren genetischem Zusammenhang mit den Serpentin-Bergbuschwäldern, während die letzteren in ihrer Struktur und floristischer Zusammensetzung den Karstbuschwäldern nahestehen.

Abb. 8. Trockener Serpentin-Dornbuschwald mit der Dominanz von micro- und nanophyllen Dorngehölzen, — *Erythroxylum minutifolium*, *Brya* sp., *Pictetia marginata*, *Rheedia cubensis* u. a. und mit *Agave brittoniana* bei Santa Clara (Villa Clara Provinz). (Foto: BORHIDI)

Die natürlichen potentiellen VEGETATION von KUBA

Maßstab: 1:1 000 000

kartiert von
A. BORHIDI und O. MUÑIZ
1969-1970



I. Regenwälder
1 Submontane Regenwälder
2 Feuchte montanen Regenwälder
3 Halbtrockene Serpentin-Bergregenwälder
4 Nebelwälder

II. Immergrüne Saisonwälder
5 Flachland-Saisonwälder
6 Submontane Saisonwälder

III. Halbimmergrüne Trockenwälder
7 Mesophile halbimmergrünen Wälder
8 Xerophile halbimmergrünen Wälder

IV. Tropische Karst- (Mogoten-) Wälder
9 Artenreiche west-kubanischen Karstwälder
10 Artenarme westkubanischen Karstwälder
11 Mittel- und Ostkubanischen Karstwälder
12 Montane Karstwälder

V. Trocken-Buschwälder und Dornbuschwälder
13 Sclerophylle Trockenbuschwälder und Dornbuschwälder
14 Trockene Kalk-Dornbuschwälder
15 Trockene Serpentin Dornbuschwälder
16 Halbtrockene Serpentin-Dornbuschwälder

VI. Halbwüsten-Vegetation
17 Kakteenreiche-Dorngebüsche

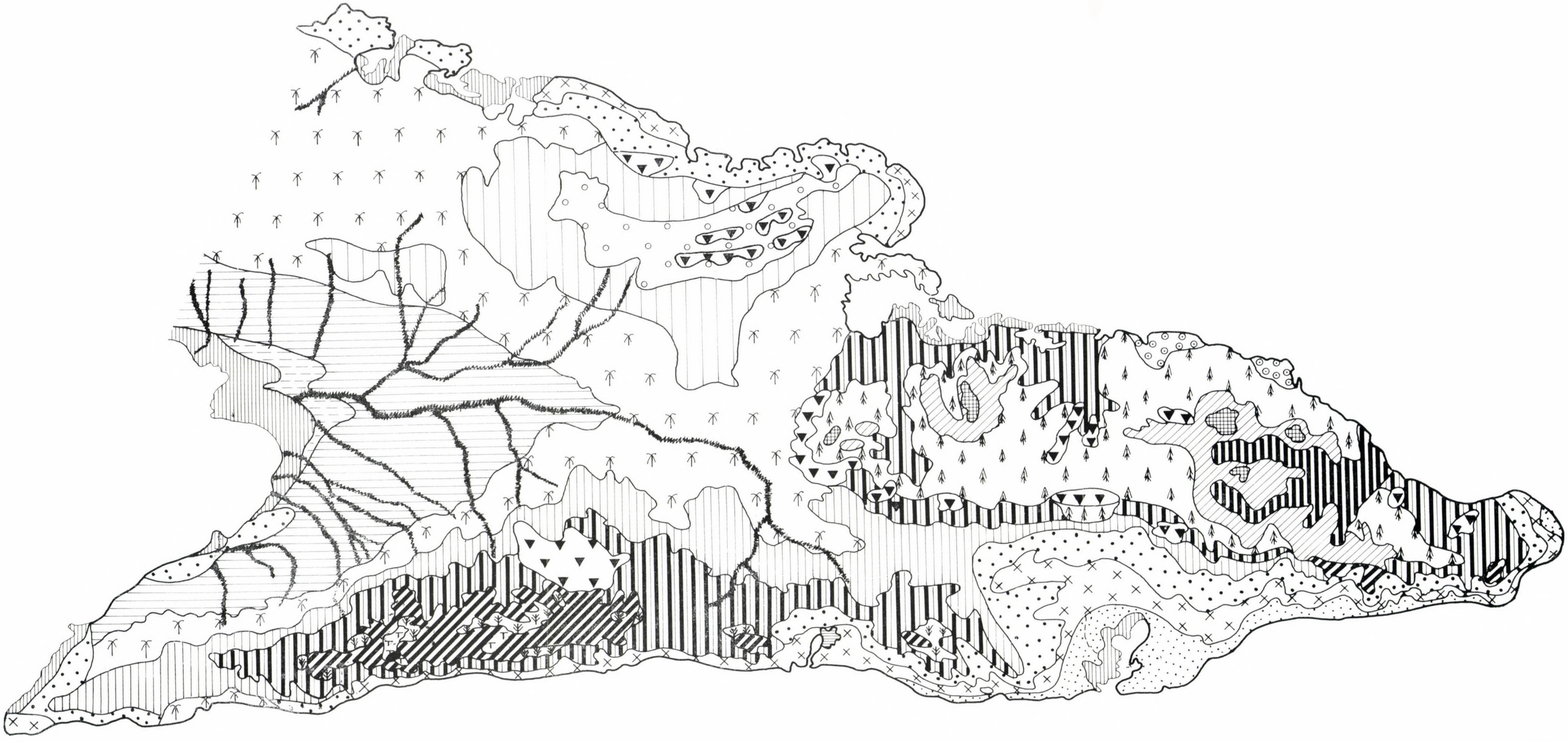
VII. Montane immergrünen Buschwälder
18 Halbtrockene Serpentin-Bergbuschwälder
19 Hochmontane immergrünen Gebüsche

VIII. Tropische Nadelwälder
20 Pinus tropicalis Sandföhrenwälder
21 Pinus tropicalis-caribaea Föhrenwälder
22 Pinus caribaea Serpentin-Föhrenwälder
23 Pinus cubensis Serpentin-Föhrenwälder
24 Baumfarnreiche montanen Föhrenwälder

IX. Savannen
25 Roystonea-Ceiba Sekundär-Savannen auf immergrünen Saisonwald-Standorten
26 Roystonea Sekundär-Savannen auf halbimmergrünen Waldstandorten
27 Copernicia-reiche Wechselfeucht-Savannen
28 Sabal-reiche Feucht-Savannen

X. Süsswasser-beeinflusste Vegetation
29 Ufer-und Sumpfwälder
30 Auenwälder
31 Baumfreie Sumpf- und Moor-Vegetation
32 Süsswasser-Vegetation

XI. Küstenvegetation
33 Mangrove-Gehölze und tropische Salzmarschen
34 Vegetation des Sand Strandes und der Fels-Küsten



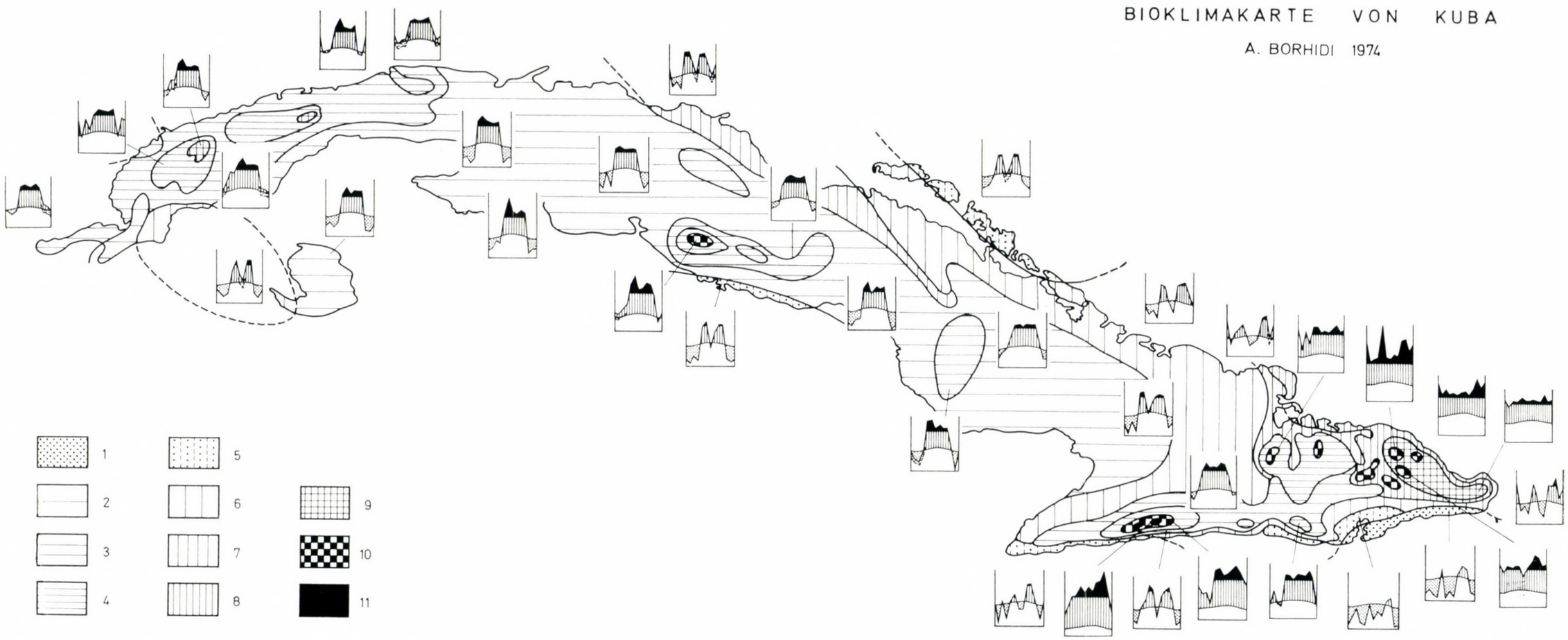


Abb. 2. Die Bioklimatypen von Kuba. (Nach Borhidi, 1974)

Erläuterung: 1. Halbwüstenklima (2c); 2—4. Zenitales Sommerregenklima mit einer Regenzeit: 2. Trockene Variante mit einer Trockenzeit von 5—6 Monaten (4b); 3 Mässig trockene Variante mit einer Trockenzeit von 3—4 Monaten (4c); 4. Subhumide Variante mit einer Trockenzeit von 1—2 Monaten (4d). 5—8. Zenitales Sommerregenklima mit zwei Trockene Variante mit Dürrezeiten von 7—8 Monaten (5a); 6. Trockene Variante mit Dürrezeiten von 5—6 Monaten (5b); 7. Mässig trokkene Variante mit Dürrezeiten von 3—4 Monaten (5c); 8. Subhumide Variante mit Trockenzeiten von 1—2 Monaten insgesamt (5d). 9. Immerfeuchtes equatoriales Regenwaldklima (6a); 10. Immerfeuchtes subequatoriales oder Bergregenwaldklima (6b); 11. Immerfeuchtes Klima der Nebelwald—Zone und der subalpinen Stufe (7a, 7b).

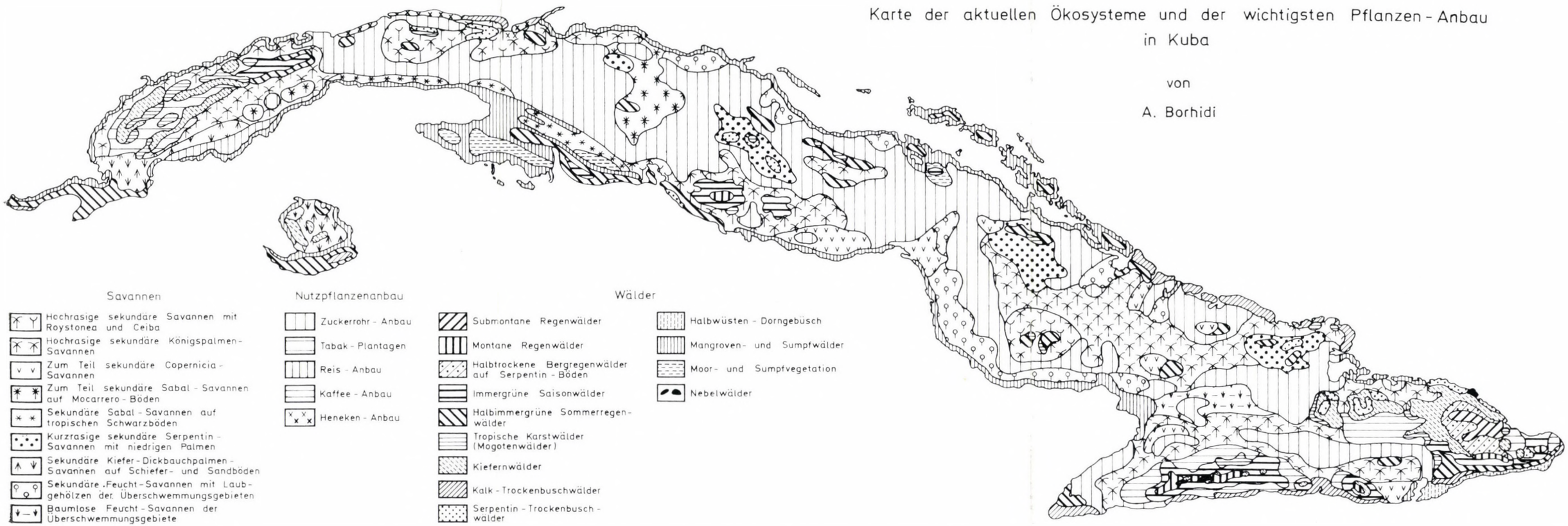
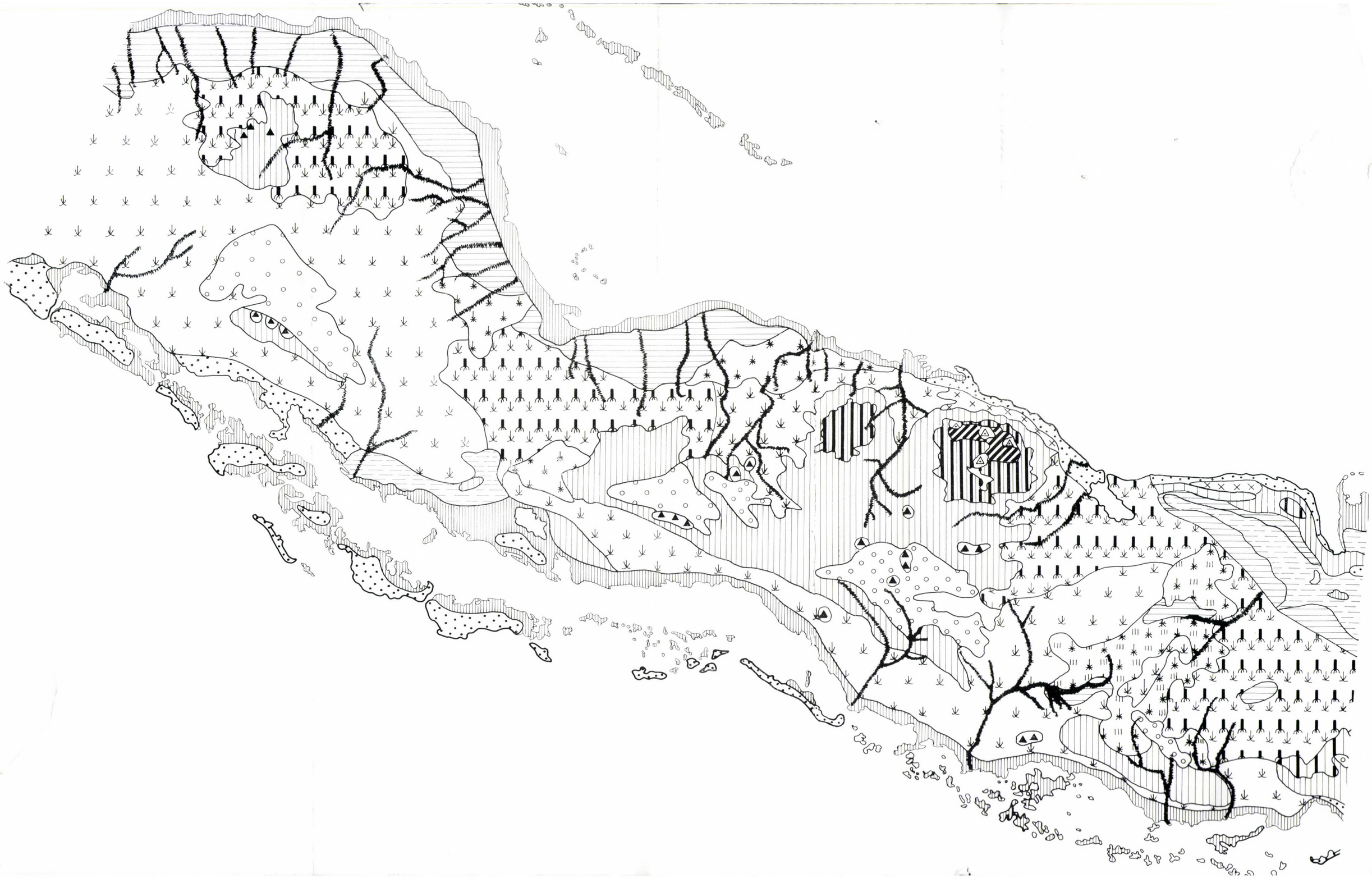


Abb. 17. Karte der aktuellen Ökosysteme und der Anbau-Gebiete der wichtigsten Kulturpflanzen in Kuba. (BORHIDI, original)



Entstehung der Savannen

Das Bild über die Vegetation von Kuba wäre nicht vollständig, wenn wir über die Savannen keine Erwähnung machten. Die ausgedehnten, prachtvollen Königspalmen-Savannen (Abb. 5) von Kuba machen auf den Turisten wie auf den Botaniker einen tiefen Eindruck. Die Klima-Atlasse nennen oft das kubanische Sommerregen-Klima Savannenklima, und auf den Vegetationskarten werden die Savannen als die zonale Vegetation von Kuba bezeichnet. Zweifelsohne machen die Wälder zur Zeit nur 8% des Landes aus und das landwirtschaftliche Gebiet und die Savannen machen 92% aus. Die theoretische Rekonstruktion der ursprünglichen Vegetation von diesem stark anthropisch beeinflußtem Gebiet war die schönste aber gleichzeitig die schwerste Aufgabe unserer Kartierungsarbeit. Wir stellten fest, daß die Insel ursprünglich in 92 bis 95% bewäldert war (Abb. 11). Klimatische Savannen kamen hier nicht vor. Die edaphischen wechselfeuchten Savannen der Überschwemmungsgebieten konnten insgesamt 3 bis 5% ausmachen. In gewissen Formationen, wo wegen Nährstoff-Armut der Böden der Stoffkreislauf langsam, und die Regenerationsfähigkeit der Ökosysteme klein war (Sand-Föhrenwälder, Serpentin-

Abb. 9. Montane immergrüne kleinblättrige Gebüsche auf dem Gipfel Pico Cuba in einer Höhe von 1860 m, mit *Ilex turquinensis*, *I. macfadyenii*, *I. nunezii* und *I. nannophylla*, *Lyonia*-Arten, *Lobelia cacuminis*, und *Agave pendentata*. (Foto: BORHIDI)

Buschwälder) war ein einmaliger drastischer Eingriff oder eine mehrmalige aber unregelmäßige Aufbrennung für Entstehung der Savannen genügend. Die Größe dieser Gebiete und den Feuergebrauch der indianischen Urbevölkerung in Betracht genommen, konnten die ursprünglichen und die Halbkultur-Savannen zur Zeit der Entdeckung Amerikas maximal 10 bis 15% der Oberfläche Kubas besetzen (Abb. 12). Im Laufe unserer Untersuchungen konnten wir beweisen, daß die Königspalmen-Savannen Kultur-Folgeprodukte der immergrünen Saisonwälder und halbimmergrünen Wälder sind; die Sabal-Savannen (Abb. 13) entstanden am Standort der Auenwälder und Sumpfwälder auf Schwarz- und Schwemmböden, die Copernicien-Savannen sind Derivate der Trockenwälder, an Stelle der heute ausgedehnten, an Zwerg- und Kleinpalmen reichen Serpentin-Savannen herrschten ursprünglich überall Kiefernwälder und Trockenbuschwälder (Abb. 14 und 15), und im Bereich der *Colpothrinax*- und Föhrensavannen lebten offene Sand-Föhrenwälder (Abb. 10).

Deshalb finden wir auf der potentiellen Vegetationskarte von Kuba nur kleine und wenige ursprüngliche Savannenflächen. Die Verbreitung der aktuellen Ökosysteme ist auf der Abb. 17 (S. auf Beilage) dargestellt.

Abb. 10. Sekundäre Savanne von *Colpothrinax wrightii* auf dem Standort der ehemaligen Sand-Kiefernwälder (Pinar del Rio Provinz). (Foto: BORHIDI)

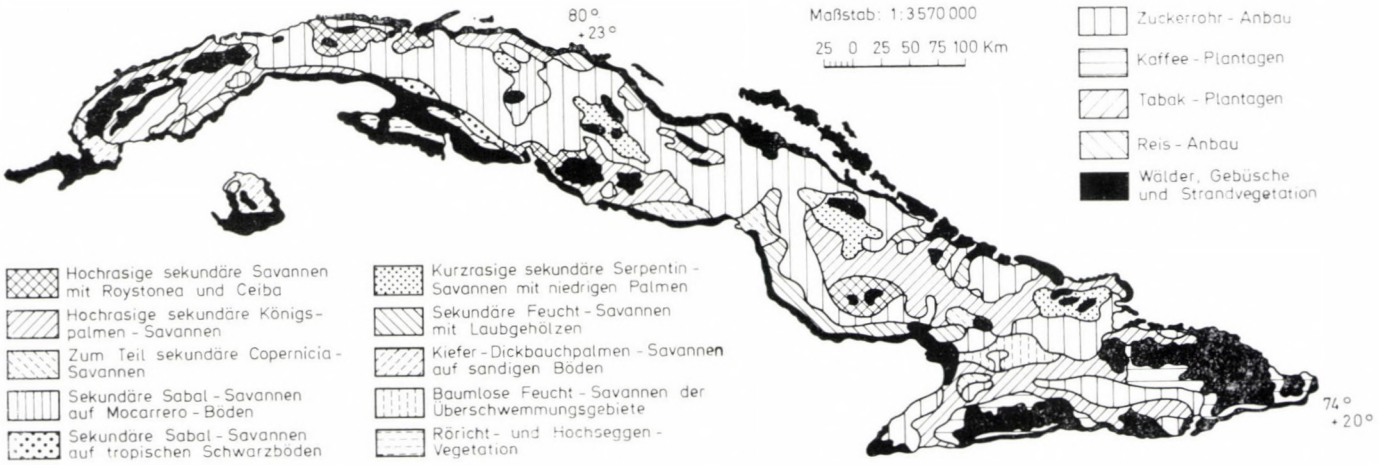


Abb. 11. Die aktuelle Verbreitung der Savannen und des wichtigsten Nutzpflanzen-Anbaues in Kuba. (Nach BORHIDI und HERRERA, 1977)

Abb. 12. Die hypothetische Verbreitung der Savannen von Kuba in 1492. (Nach BORHIDI in BORHIDI und HERRERA, 1977)

Abb. 13. Sabal-reiche Feucht-Savannen auf dem Standort der ehemaligen Sumpfwälder, (stark beweidet) auf der Zapata Halbinsel (Matanzas Provinz). (Foto: BORHIDI)

Abb. 14. Stark beweidete Serpentin-Savanne bei Santa Clara, mit *Gastrococos* Palmen. (Foto: BORHIDI)

Abb. 15. Zwergpalmen-Savanne mit *Coccothrinax moaensis* auf flachgründigem Serpentin-Latosolboden mit einer Eisenstein-Schicht, auf dem Standort der ehemaligen *Pinus cubensis* Kiefernwälder. (Foto: BORHIDI)

Abb. 16. Palmenreiche halbimmergrüne Kalk-Dorngebüsche im Ost-Kuba bei Maisi, mit *Coccothrinax alexandri* Palmen. (Foto: BORHIDI)

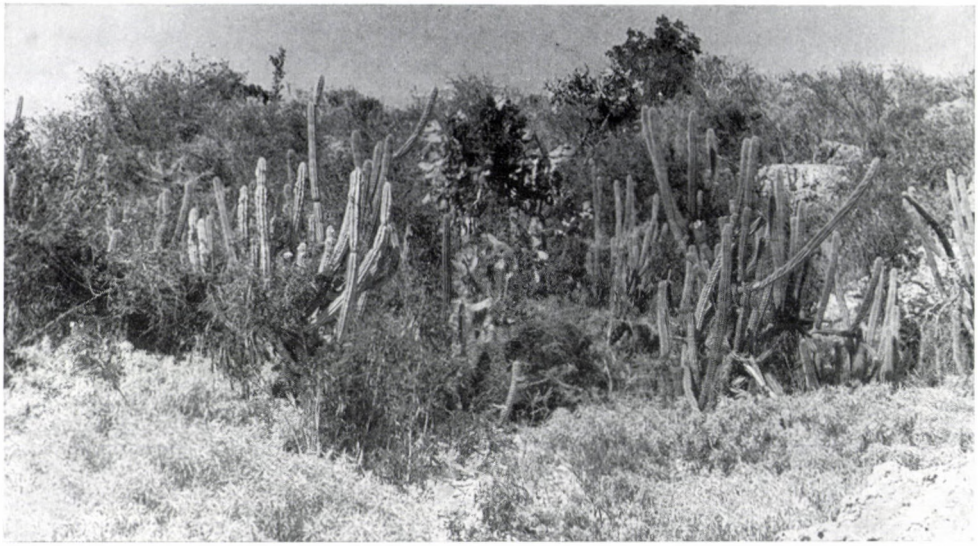


Abb. 18. Säulenkakteen-Gesellschaft im Bereich der Halbwüsten-Zone von Kuba, bei Baitiquiri (Guantánamo-Provinz), mit *Lemairocereus hystrix*, *Pilosocereus brooksianus*, *Consolea macracantha*, *Capparis*- und *Croton*-Arten. (Foto: Borhidi)

Abb. 19. Halbwüsten-Dorngebüsch auf den steinigen Standorten der Kalk-Terrassen im SO-Kuba, bei Macambo, mit *Agave albescens*, *Melocactus harlowii*, *Jacquinia*- und *Lantana*- Arten. (Foto: Borhidi)

Halbwüsten-Dorngebüsche

In den extrem trockenen Küstengebieten von Oriente—bei Gibara, Cabo Cruz und besonders zwischen Daiquiri und Maisi gedeihen mächtige kakteenreiche Dorngebüsche. Auf den sandigen Böden der unteren Terrassen leben die säulenkakteenreichen Dornbuschwälder mit *Lemairocereus hystrix, Pilosocereus brooksianus, Cylindropuntia hystrix, Guajacum officinale, Acacia-, Capparis-* und *Croton*-Arten (Abb. 18). Auf den höheren Terrassen hingegen entwickelt sich ein lockeres Dorngebüsch mit vielen verschiedenen Assoziationen, reich an Agaven, baumförmigen Kakteen (*Consolea*-Arten), xeromorphen Palmen (*Haitiella munizii, Coccothrinax alexandri, C. fragrans*), *Melocactus-, Lantana-, Cordia-, Tabebuia-* und *Rondeletia*-Arten (Abb. 19).

Einige Merkmale der Flora von Kuba

Es ist unerläßlich ein Paar Worte über den Gesamtcharakter der Flora von Kuba zu sagen, ist sie doch eine der reichsten Insel-Flora in der Welt. Laut unserer heutigen Kenntnissen (BORHIDI, 1973, 1976) enthält sie 6700 Arten der Gefäßpflanzen, wovon etwa 500 Pteridophyten und ungefähr 6200 Phanerogamen sind. 51,3 Prozent dieser Phanerogamen-Flora sind endemisch, mehr als 3100 Arten der Blütenpflanzen kommen außer Kuba nicht vor; 60% der Flora machen die Bäume und Sträucher, und nur 40% die Gräser und Kräuter aus. In Kuba leben 71 endemische Gattungen von verschiedenem Alter und ökologischem Anspruch (Tabelle 3). Diese Tatsache muß betont sein wegen einer Zusammensetzung von HOWARD (1973), die nur 40 endemische Gattungen für Kuba anerkannt hat.

Entwicklungsphasen der Flora

In der Entwickelung der Flora sind 3 große Perioden zu unterscheiden. Die erste können wir als *Plattenphase* nennen, die in die Jura- und Kreidezeit zu legen ist. In dieser Zeit erhebt sich die Platte der Antillen und nördlich vom Afro-amerikanischen Superkontinent erst mit der Makaronesischen Platte, dann in west-östlicher Richtung schwimmend kommt sie mit pazifischen Flora in Beziehung. Die makaronesische Beziehung scheint mit dem Vorkommen der *Cneorum trimerum* und *Dracaena cubensis*; die pazifische Beziehung mit der *Colpothrinax-Pritchardia* Verwandtschaft bezeugt zu sein.

Die zweite Periode ist die *Landbrücken-Phase* die von der Eozänzeit bis zur Pliozänzeit dauert. In dieser Periode waren die Antillen durch die Honduras- und Yucatan-Halbinsel, später infolge der Erhebung der Kleinen Antillen durch mehrere Landbrücken mit dem amerikanischen Kontinent in Verbindung. Das ist die Phase der wichtigsten Einwanderungen der neotropischen Flora.

Tabelle 3

Übersicht der endemischen Phanerogamen-Gattungen von Kuba und die edaphischen Verhältnisse ihres Vorkommens

	Arten Zahl	Kalk	Sand-stein	Sand	Serpen-tin	Übrige Ge-steine
Acanthaceae						
Ancistranthus	1	1	—	—	—	—
Dasytropis	1	—	—	—	1	—
Phidiasia	1	—	—	—	1	—
Sapphoa	2	—	—	—	2	—
Amaranthaceae						
Goerziella	1	1	—	—	—	—
Woehleria	1	+	—	—	—	+
Anacardiaceae						
Euleria	1	1	—	—	—	—
Araliaceae						
Megalopanax	1	1	—	—	—	—
Bignoniaceae						
Spirotecoma	5	2	—	—	3	—
Synapsis	1	1	—	—	—	—
Cactaceae						
Dendrocereus	1	1	—	—	—	—
Caryophyllaceae						
Pinosia	2	1	—	1	—	—
Compositae						
Ciceronia	1	—	—	—	1	—
Ekmania	1	1	—	—	—	—
Feddea	1	—	—	—	1	—
Harnackia	1	—	—	—	1	—
Heptanthus	7	1	1	1	4	—
Koehneola	1	—	—	—	1	—
Lachnorrhiza	1	—	+	+	+	—
Lescaillea	—	—	—	—	1	—
Phania	2	1	+	—	1	—
Rhodogeron	1	—	—	—	—	1
Shafera	1	—	—	—	1	—
Spaniopappus	1	1	—	—	—	—
Tetraperone	1	—	1	—	—	—

Tabelle 3 (Fortsetzung)

	Arten Zahl	Kalk	Sand-stein	Sand	Serpen-tin	Übrige Ge-steine
Cycadaceae						
Microcycas	1	+	+	—	—	—
Euphorbiaceae						
Cubacroton	1	1	—	—	—	—
Moacroton	7	—	—	—	7	—
Platygyne	7	1	1	1	4	2
Fabaceae						
Behaimia	2	+	+	—	+	+
Belairia	6	3	1	1	1	1
Bembicidium	1	1	—	—	—	—
Hebestigma	1	+	+	—	+	+
Herpyza	1	—	+	+	—	—
Notodon	4	2	—	—	2	—
Sauvallella	1	—	—	—	1	—
Gentianaceae						
Zonanthus	1	1 (?)	—	—	—	—
Gramineae						
Chaetium	1	+	—	—	+	—
Ekmanochloa	2	—	—	—	2	—
Lepturidium	1	—	—	1	—	—
Mniochloa	2	+	+	—	+	+
Triscenia	1	+	—	—	+	+
Malpighiaceae						
Henleophytum	1	+	—	—	+	—
Myrsinaceae						
Solonia	1	—	—	—	—	1
Myrtaceae						
Krokia s. l.	11	2	—	—	8	1
Mozartia	8	1	—	—	5	2
Nyctaginaceae						
Caribaea	1	1	—	—	—	—
Palmae						
Gastrococos	1	+	—	—	+	+
Hemithrinax	4	2	—	—	2	—
Rhamnaceae						
Doerpfeldia	1	1	—	—	—	—

Tabelle 3 (Fortsetzung)

	Arten Zahl	Kalk	Sand-stein	Sand	Serpen-tin	Übrige Ge-steine
Rubiaceae						
Acunaeanthus	1	—	—	—	—	1
Ariadne	2	—	—	—	2	—
Ceratopyxis	1	1	—	—	—	—
Ceuthocarpus	1	—	—	—	—	1
Eosanthe	1	—	—	—	1	—
Nodocarpaea	1	—	—	1	—	—
Phyllacanthus	1	—	—	—	?	—
Phyllomelia	1	—	—	—	1	—
Shaferocharis	3	—	—	—	3	—
Schmidtottia	16	—	—	—	16	—
Siemensia	1	1	—	—	—	—
Rutaceae						
Kodalyodendron	1	—	—	—	1	—
Sapindaceae						
Euchorium	1	1	—	—	—	—
Scrophulariaceae						
Amphiolanthus	3	+	+	+	—	+
Encopella	1	—	—	+	—	+
Solanaceae						
Espadaea	1	+	+	—	+	+
Henoonia	1	+	—	—	+	—
Thymelaeaceae						
Linodendron	3	—	—	—	2	1
Tiliaceae						
Tetralix	5	—	—	—	5	—
Turneraceae						
Adenoa	1	—	—	—	1	—
Umbelliferae						
Asciadium	1	—	—	1	—	—

Die dritte Periode ist die *Insel-Phase,* die in Kuba schon in der Oberen Miozänzeit beginnt; die wesentlichen Merkmale dieser Periode sind die Trennung der Inseln vom Kontinent und voneinander, die Spezialisation der Flora, und die Entwicklung der Mannigfaltigkeit der endemischen Sippen.

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DIE PALYNOLOGISCHE ERFORSCHUNG DES QUARTÄRS IN BERLIN (WEST)

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Documenting the present research state of quaternary palynology in Berlin (West) special interest refers to the pleistocene evidence of the holocene development type of pine-rich woodland in the sandy parts of this climatically subcontinental influenced last glacial-formed landscape.

Einleitung

Palynologische Forschung im großstädtischen Raum gründet sich auf die Nutzungsansprüche an erdgeschichtliche Ressourcen und heutige Ökosysteme. Eine umfaßende landschaftsgeschichtliche Analyse palynologischer Befunde, wie sie ZÓLYOMI (1953) im Balaton-Gebiet unternahm, bedarf gerade hier zugunsten von Schutz und Erhaltung natürlicher Landschaftsfunktionen einer konsequenten Anwendung und Entwicklung. Dabei erlangen im Berliner Raum mit dem Rezentnachweis ZÓLYOMIS (1936) von *Urtica kioviensis* selbst arealgeographische Beziehungen zum ungarischen Tiefland für die Floren- und Klimageschichte Beachtung (KONCZAK et al., 1968).

Anhand von Verbreitungskarten miozäner und quartärer Ablagerungen in Berlin (West) wird eine Dokumentation des gegenwärtigen Kenntnisstandes gegeben. Sie stützt sich für das Pleistozän teilweise auf ERD (1960a, b) und strebt für die pollenanalytischen Untersuchungspunkte Vollständigkeit an. Für die Verbreitungsgrenzen der miozänen und holsteinzeitlichen Ablagerungen im Südteil sind Ergänzungen in nächster Zeit zu erwarten.

Präquartär

Abb. 1 zeigt die Verbreitung des mit ca. 90% Flächenanteil die Tertiäroberkante bildenden braunkohle führenden Miozäns nach GOCHT (1963) und FREY (1975). Der palynologischen Untersuchung der Braunkohlenflöze (a—g) steht der Nachweis tertiärer Pollenführung in pleistozänen Umlagerungen gegenüber (1—3, 22), die in allen drei Vereisungskomplexen Berlins stattfanden. Er wurde besonders im Falle der als Holzkohle bezeichneten Lagen in fluvialen Sanden (3) bedeutsam, deren vorherige Radiocarbondatierungen ein weichselzeitliches Alter ergeben hatten (MOLLE und SCHULZ, 1975).

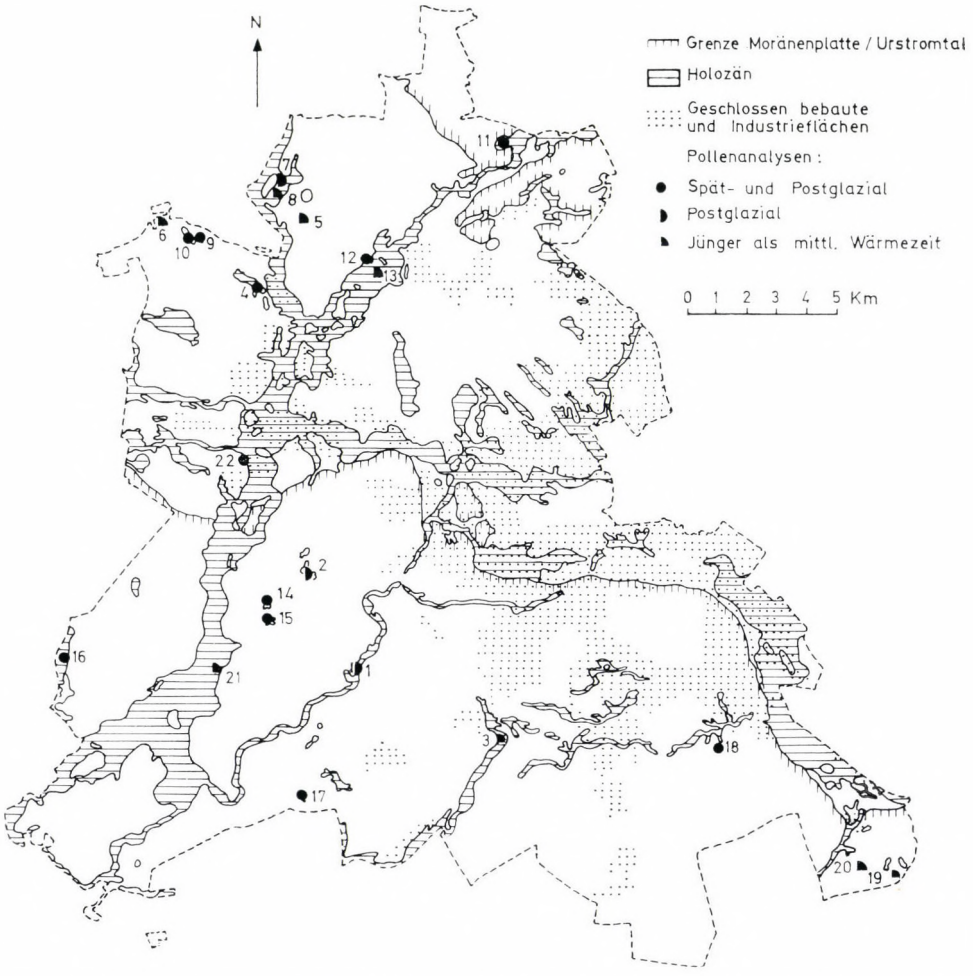

Abb. 1. Verbreitung pollenanalytisch untersuchter mio- und pleistozäner Ablagerungen in Berlin (West). Untersuchungspunkte (Ortsbezeichnungen s. bei den Autoren): a—f = RAUKOPF (1959), g = MEYER in MÜLLER (1974b), 1—2 = THIERGART (1965), 3 = BRANDE (unveröff.), 4 = HECK (1930), 5—7 = HALLIK in GOCHT (1963), 8—19 = MÜLLER (1974b), 20 = KAUNHOWEN und STOLLER (1926), 21 = KUNTH (1865), 22 = BÖSE und BRANDE (1979), 23 = STOLLER (1926), 24 = z. B. WAHNSCHAFFE (1906), DIETRICH (1932)

Holstein-Warmzeit

Die ältesten warmzeitlichen Ablagerungen des Quartärs sind hier die Berliner Paludinenschichten mit dem Locus typicus der *Paludina diluviana* in (21). Die bisher bekannte Verbreitung dieser holsteinzeitlichen Sedimente nach ASSMANN (1957), GOCHT (1963) und FREY (1975) umfaßt mindestens 60% der Fläche.

Die Pollenführung des bereits außerhalb gelegenen Punktes (4) und pflanzliche Großrestfunde in (20) hat ERD (1960a) diskutiert. Nach Untersuchung weniger Proben in (5—7) ergab erst die Summe zahlreicher Einzelproben aus mehreren Spülbohrungen im Bereich der pleistozänen Tegeler Rinne (8—19) eine relativ vollständige holsteinzeitliche Abfolge (FREY, 1975). Sie erlaubt nach MÜLLER (1974b) eine direkte Zuordnung zu den Abschnitten der holsteinzeitlichen Vegetationsentwicklung der Lüneburger Heide (MÜLLER, 1974a) und zeigt ähnlich wie dort eine wechselnde Dominanz von *Pinus* und *Alnus* sowie vereinzelt von *Quercus* und *Corylus* in den mittleren Interglazialphasen. Die Ausscheidung des bisher einzigen Areals vermutlich dömnitzzeitlicher Ablagerungen im Sinne von ERD (1970) ergab sich im Falle von drei Proben in (17—19) im Hangenden der oberen Holstein-Abfolge durch die Zuordnung MÜLLERS (1974b) zum Abschnitt XVI von Munster-Breloh (MÜLLER, 1974a).

Weitere Untersuchungspunkte der Holstein-Warmzeit einschließlich eines als rügenzeitlich eingestuften Vorkommens im näheren Umkreis nennt CEPEK (1967).

Eem-Warmzeit

Die Darstellung der Eem-Vorkommen in Abb. 1 beruht auf KORN (1928), ASSMANN (1957), Geol. Karte Berlin 1 : 10 000, Bl. 403/4, 413/4 (1957—1969) und BÖSE und BRANDE (1979). Insgesamt sind über 100 kleine Areale limnischer und telmatischer Vorkommen durch Bohrungen bekannt geworden, die sich besonders im Südteil der Stadt häufen (GOCHT, 1970). Ihr Flächenanteil dürfte aber 5% nicht überschreiten. Aufschlüsse entstanden z. B. in Staaken, Lichterfelde, in (22, 23) sowie, lediglich mit umgelagerter Faunenkomponente des Eem, im Rixdorfer Horizont (24).

Nach der Analyse pflanzlicher Großreste (23) und spärlichen Angaben zur Pollenführung (20) liegt eine palynologisch gesicherte Überprüfung des Eem nur in (22) vor. Die pollenstratigraphische Gliederung folgt hier sowohl niederlausitzer wie nordwestdeutschen Merkmalen. Das Diagramm zeigt aber eigene Züge wie anhaltende *Pinus*-Dominanz mindestens bis in die *Carpinus*-reiche Zeit und *Corylus*-Werte, die nicht über den bisher in Berlin aus dem Holstein und Holozän bekannten liegen. Eine ähnlich starke *Taxus*-Ausbreitung wie in den laubholzreicheren Landschaften war vermutlich durch die geringere Schattenwirkung der *Pinus*-reichen Wälder möglich. Das Fehlen der in manchen Teilen Nordwestdeutschlands typischen *Tilia-Taxus*-Zeit geht auf die spätere *Tilia*-Ausbreitung zurück. Sie erfolgt zusammen mit der von *Carpinus*, die aus östlicher Richtung einwanderte.

In der Umgebung von Berlin (West) sind eemzeitliche Ablagerungen nach CEPEK (1967, 1972) an mehreren Stellen palynologisch bearbeitet worden.

Weichsel-Kaltzeit

An weichsel-interstadialen Vorkommen liegt abgesehen von der entsprechenden, nach CEPEK (1967) wahrscheinlich mit glazifluvialen Vorschüttbildungen des weichselzeitlichen Eises umgelagerten Faunenkomponente in (24) und einem palynologisch unsicheren Fund im äußersten Nordteil (MÜLLER, 1974b) nur in (22) ein Fragment wenige dm über dem Eem vor. Die Pollenführung zeigt eine progressive Vegetationsentwicklung bei einem gewissen Thermophilenanteil und *Larix* auf vermutlich primärer Lagerstätte und gehört

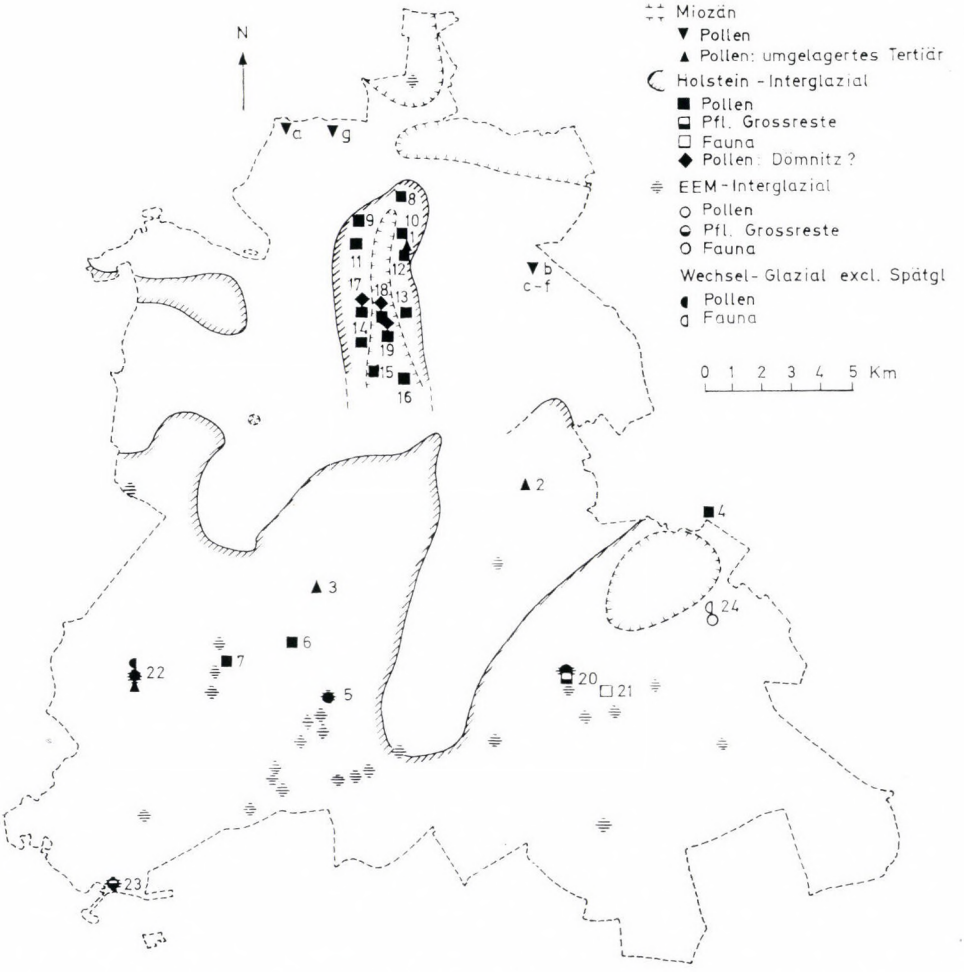

Abb. 2. Verbreitung der pollenanalytisch untersuchten holozänen Ablagerungen in Berlin (West). Untersuchungspunkte (Ortsbezeichnungen s. bei BRANDE 1978/79): 1—2 = HEIN (1931), 3 = THIERGART und FRANTZ (1964), 4 = MÜLLER (1965), 5 = TRAUTMANN (unveröff.), 6 = LANGE (1975, 1976), 7—22 = laufende Untersuchungen

mit einem Gehölzpollenanteil von 90% eher dem früh- als dem mittelweichselzeitlichen Komplex an.

Abb. 2 enthält mit dem Holozän auch die mehrfach untersuchten spätglazialen Schichten. Sie zeichnen sich durch den allerödzeitlichen Laacher Tuff in zumeist noch limnischem Sediment über dem Niveau der *Pinus*-Massenausbreitung aus und weisen auf lichte, *Juniperus*-reiche *Pinus-Betula*-Wälder und Sandumlagerungen im Urstromtal während der jüngeren Tundrenzeit hin.

Holozän

Die Verbreitung der ca. 16% flächendeckenden Holozänablagerungen ermöglicht eine palynologische Bearbeitung aller Teile der glazial geformten Landschaft. Die Waldzeitengliederung ist auch bei der hohen *Pinus*-Dominanz in den Sandgebieten der Täler und Kames durch das Verhalten der Laubhölzer bestimmt. Die seit dem neolithischen *Ulmus*-Rückgang nachweisbare Landnutzung und die anthropogene Umgestaltung der Landschaft — ein Schwerpunkt der palynologischen Erforschung des Stadtgebietes (Brande, 1978/79) — ist besonders in Sedimenten früherer Siedlungsplätze selbst zu untersuchen. So sind bisher bei (3, 6, 17, 22) einzelne Abschnitte von der Bronzezeit bis zur frühdeutschen Zeit erfaßt, während der neuzeitliche Landschaftswandel in den unverbauten Bereichen vielfach auch flächenhaft in Aufbau und pollenfloristischem Inhalt der Sedimente zum Ausdruck kommt.

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COMPARATIVE EXPERIMENTAL MORPHOLOGICAL INVESTIGATIONS ON POPULATIONS OF *FESTUCA VAGINATA* W. ET K., I.*

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Individuals of *Festuca vaginata* populations of three areas lying distant from one another (Hungary: Neszmély, Vácrátót, Fülöpháza) were reciprocally transplanted with an aim to observe whether morphological changes would occur in the florescence of the populations that underwent transplantation. In 1978, the variability of the morphological characters (the length of the panicle, the internode and the panicle awn, the length of the glume exterior and inferior and of the palea) of the populations of original habitats and those in transplanted populations was studied. The two populations from Vácrátót with different spikelet colour were examined in 1977–1978. Of the characters examined in the three populations the length of the branch of the panicle, of the internode and of the glumes show the species interrelatedness in the populations of the original habitat, while the differences within the species are indicated by the length of the panicle, and of the palea, as well as by the formation of the awn of the palea. The individuals of the populations transplanted to Fülöpháza and Vácrátót could be compared with the local populations in 1978. On the basis of the investigations the panicle lengths discriminating the populations can only be considered as plastic ecomorphosis.

A method of comparative population investigation is to establish identical conditions in experimental garden and to plant into it populations originating from different habitats: another way is to reciprocally transplant parts of different populations. In both cases we can study how the populations behave under changed conditions: in the first case we receive an answer to the question how the populations react to uniform conditions, while in the second we can determine the tolerance of the populations under varying conditions.

Since it can be supposed that the various populations show certain differences also in relation to the various morphological characters which are (probably) not determined genetically, we asked whether after a certain time the transplanted population parts in the new habitat will show the characters of the local population. To answer this question our experiments were set up.

Festuca vaginata, the dominant species of sandy meadows, was reciprocally transplanted among three habitats with an aim to examining whether morphological changes would occur after the transplantation among the populations growing far from one another and to what extent they would last.

* 'Tece Studies', No. 15

Material and method

Individuals of three *Festuca vaginata* populations lying far from one another were reciprocally transplanted, in the beginning of October, 1977. The localities and their abbreviations: Neszmély (N), Vácrátót (V), and Fülöpháza (F); the capital letter placed in subindex indicates the habitat from which the plants were transplanted, for example: F_N = plants transplanted to Fülöpháza and originating from Neszmély.

At the time of blossoming, in the population of Vácrátót, waxy individuals of gray and greenish colour, with yellow spikes, can be distinguished. These — although they distinctly belong to species *Festuca vaginata* — were placed in a separate group in the comparisons, and indicated by symbols V_g and V_y. This characteristic was not taken into consideration when transplanting the plants.

Owing to the extreme conditions of transplantation and habitats, the plants in 1978 were not yet developed enough to endure the taking of samples (for example, many of them did not bring forth flowers, there was no proliferation of young shoots bearing leaves). Thus the material necessary for making comparisons was only available to a restricted extent.

Of the populations of the three sampling areas we had samples suitable for comparisons from the years 1977 and 1978.

With respect to our earlier investigations (localised sampling; HORÁNSZKY, 1970; CSÁNYI-KOVÁCS—HORÁNSZKY, 1973) in determining the size of the glume and of the palea, it was considered best for analysis to take the single spikelet second from below at the apex of the panicle. Within the spikelet, the paleas were examined by treating them separately according to also their position — level of height — and by numbering them in an upward order indicating them as *P 1*, *P 2* etc. (see the tables below). In addition to these characteristics, the length of the panicle of its lowest internode, and of the longest side-branch to be found at its lowest node was also measured. Hereinafter these characters will be mentioned as panicle-, internode-, and branch lengths.

The analysis of variance (ANOVA) was used comparing and evaluating the populations. For the various ANOVAs the individuals considered were not necessarily always identical, therefore, the averages of identical groups do not always correspond numerically.

Results

The characteristics of the populations at their original habitats (1978)

It can be inferred as a general conclusion that essentially greater variances appear within the populations than among the populations.

In 1978, certain characteristics of the populations of the three sampling areas do not show significant values among the populations, while other characteristics do so. This allows us to draw the conclusion that the characteristics form two groups. Since the populations examined belong to the best of our knowledge to a single species, the characteristics showing agreement can be stated as species characteristics — testifying to the relatedness of the populations — as against those in which significant differences can be found, and are characteristics of infraspecific groups, populations. The latter can be considered at most as of microtaxonomical values, that is, as characteristics suitable for the identification of infraspecific units or populations. The tendency manifesting itself here can, however, be accurately confirmed only by means of numerous further examinations. On the basis of the above considerations, the length of the panicle branch and of the internode, as well as that of the glumes seems a species characteristic indicating the relatedness of the populations.

Characteristics for the population — showing differences within the species — are the panicle length, the palea length (analysed according to position *P 1—P 4*) and the awn of the palea.

With respect to the internode length, the *F*-test was not significant, this was the case for the panicle branch and the length of the two glumes.

As regards the panicle length, its values were not significant with respect to the two colour variants of Vácrátót between themselves, and to the differences between *N* and the two *V* population. *F* was different from both *N* and the two *V* populations. Thus, *V* and *N* corresponded, while *F* differed from both.

The palea length was analysed according to the method of localised sampling, not only by choosing always an identical position of the spikelet, but within that also the height levels were examined in a separate treatment. The fifth group is a mixed one, not chosen by the position (Table 1).

In three comparisons, at all the four palea levels significant values were obtained in relation to $N—V_y$; $N—V_g$; and $N—F$. It is interesting to note that it was only between *N* and the two *V*-groups that differences occurred in the case of mixed samplings too. Differences between V_g and *F* occurred in two layers, namely in layers 1 and 3. There occurred one difference between *F* and *V*, in palea layer 1, and also one difference between V_y and V_g, in layer 3.

It seems that the most stable difference occurs between the two V_s and the *N* populations, while between *V* and *F* this develops similarly only in layer 1. The difference in relation to $N—F$ is unambiguous in all the layers.

According to the sampling not localised (mixed) within the spikelets the differences are blurred. It is only between $N—V$ that they remain even in this way of sampling. This can indicate that the sampling localised within the spikelet is more suitable for the elaboration of the differences occurring within populations than is the mixed, random sampling.

Length of awn. *Festuca vaginata* in general consists of palea without awns. In the plants examined, awns developed even though only sporadically. Thus, owing to the small number of sample elements, evaluation could not be carried out by analysis of variance. Even so, a certain tendency can however be analysed in this characteristic. The occurrence of the awn is 0.3% in Fülöpháza, 7.55% in Vácrátót, 15% in Neszmély. Going northwards we can frequently find individuals with palea having awns.

The characteristics of the transplanted individuals (1978)

The plants transplanted to Fülöpháza and Vácrátót were examined in 1978, in comparison with the local populations (Tables 2 and 3). The populations transplanted to Vácrátót were compared separately with the V_g and

Table 1

Analysis of variance of the morphological characteristics of the populations (1978)

a) *ANOVA results*

Characters		SQ	df	MQ
Panicle length	populations	90.76	3	30.25
	error	311.60	48	6.49
Internode length	populations	1.52	3	0.51
	error	43.04	36	1.2
Branch length	populations	12.84	3	4.28
	error	73.84	36	2.05
Glume interior	populations	0.31	3	0.1
	error	4.25	36	0.12
Glume exterior	populations	0.2	3	0.07
	error	11.78	48	0.25
P 1.	populations	2.62	3	0.87
	error	1.16	48	0.02
P 2.	populations	2.14	3	0.71
	error	4.62	48	0.1
P 3.	populations	1.13	3	0.38
	error	0.24	48	0.01
P 4.	populations	1.15	3	0.38
	error	5.73	48	0.12
P mixed	populations	2.48	3	0.83
	error	6.37	48	0.13

b) *Comparative table of means*

Characters	V_y	V_g	V_N	F	S.E.
Panicle length, cm	10.83	9.85	10.43	13.32	0.71
Internode length, cm	3.69	3.24	3.27	3.59	0.35
Branch length, cm	4.71	4.12	3.66	5.15	0.45
Glume interior, mm	1.92	2.00	2.15	1.95	0.11
Glume exterior, mm	2.98	2.88	3.08	2.96	0.14
P 1.	3.40	3.35	3.92	3.54	0.04
P 2.	3.56	3.37	3.92	3.54	0.09
P 3.	3.27	3.15	3.56	3.29	0.02
P 4.	3.04	3.02	3.39	3.10	0.09
P mixed	3.15	3.13	3.67	3.40	0.10

the V_y populations. According to the result of the examination, the transplanted populations were in agreement with respect to all the characteristics with V_g; the only difference occurred between the V and N populations, in the *P 2* layer of the populations at Fülöpháza; also the difference in internode lengths was significant between the transplanted populations in Vácrátót and the V_y populations.

Judging from the results it seems that the local climatic factors — expectably the combined effect of the moisture content and the temperature on the panicle growth — influence the length of the panicle, since the transplanted plants seemed to be in agreement with the local populations which were different from one another. This suggests that also this characteristics distinguishing the populations from one another represent only plastic ecomorphosis.

The different internode lengths occurring after the transplantation, in comparison with the local populations where they are shown to be in agreement, can probably be explained by experimental error. The correspondence, shown in the *P* layers is also contradictory compared with the difference-

Table 2

Analysis of variance in populations transplanted to Vácrátót, and in local populations of Vácrátót, with respect to the morphological characteristics (1978)

a) *ANOVA results*

Characters		SQ	df	MQ
Panicle length	populations	15.64	2	7.82
	error	174.21	27	6.45
Internode length	populations	6.06	2	3.03
	error	18.55	27	0.69
Branch length	populations	4.09	2	2.05
	error	33.16	24	1.38
Glume interior	populations	0.06	2	0.03
	error	4.41	27	0.16
Glume exterior	populations	0.28	2	0.14
	error	2.23	27	0.08
P 1.	populations	0.07	2	0.04
	error	6.87	27	0.25
P 2.	populations	0.20	2	0.10
	error	4.85	27	0.18
P 3.	populations	0.76	2	0.38
	error	2.23	27	0.19

b) *Comparative table of means*

Characters	V_y	V_N	V_F	S.E.
Panicle length, cm	10.29	9.97	11.64	0.80
Internode length, cm	3.69	2.61	2.96	0.26
Branch length, cm	4.38	3.74	3.44	0.39
Glume interior, mm	1.92	1.95	2.02	0.13
Glume exterior, mm	3.00	3.17	2.95	0.09
P 1.	3.32	3.42	3.42	0.16
P 2.	3.55	3.57	3.37	0.13
P 3.	2.85	3.40	3.10	0.19

a) *ANOVA results*

Characters		SQ	df	MQ
Panicle length	populations	2.56	2	1.28
	error	189.43	27	7.02
Internode length	populations	2.03	2	1.02
	error	18.37	27	0.68
Branch length	populations	3.80	2	1.90
	error	31.43	24	1.31
Glume interior	populations	0.03	2	0.02
	error	4.53	27	0.17
Glume exterior	populations	0.43	2	0.22
	error	4.76	27	0.18
P 1.	populations	0.02	2	0.01
	error	3.79	27	0.14
P 2.	populations	0.24	2	0.12
	error	5.44	27	0.20
P 3.	populations	0.90	2	0.45
	error	2.20	12	0.18

b) *Comparative table of means*

Characters	V_g	V_N	V_F	S.E.
Panicle length, cm	9.63	9.97	11.64	0.84
Internode length, cm	3.24	2.61	2.96	0.26
Branch length, cm	3.96	3.74	3.44	0.38
Glume interior, mm	2.00	1.95	2.02	0.13
Glume exterior, mm	2.9	3.17	2.95	0.13
P 1.	3.37	3.42	3.42	0.12
P 2.	3.40	3.57	3.37	0.14
P 3.	2.80	3.40	3.10	0.19

occurring in the local populations, and outlined in great variety: a significant value occurred only at Fülöpháza, in layer *P 2.*

The results could more reliable if the local and the transplanted populations could be compared in the same years, but for the time being our material does not make this possible.

The characteristics of the populations at Vácrátót, in 1977 and 1978

The variance analysis of the examined V_g and V_y populations studied in different years (1977 and 1978) did not in a single case give significant values (Table 4). This can be an indication that the local factors did not significantly influence the changes in the characteristics of the local populations studied in the two years.

Table 3

Analysis of variance in populations transplanted to Fülöpháza and in local populations at Fülöpháza, with respect to their morphological characteristics

a) *ANOVA results*

Characters		SQ	df	MQ
Panicle length	populations	27.25	2	13.63
	error	233.93	27	8.66
Internode length	populations	4.36	2	2.18
	error	23.11	27	0.86
Branch length	populations	5.17	2	2.59
	error	89.63	27	3.32
Glume interior	populations	0.01	2	0.01
	error	2.63	27	0.23
Glume exterior	populations	0.03	2	0.02
	error	5.59	27	0.21
P 1.	populations	0.71	2	0.36
	error	4.26	27	0.16
P 2.	populations	1.51	2	0.76
	error	2.91	27	0.11
P 3.	populations	1.08	2	0.54
	error	4.92	27	0.18

b) *Comparative table of means*

Characters	F	F_V	F_N	S.E.
Panicle length, cm	12.80	11.20	10.60	0.93
Internode length, cm	3.59	2.88	2.71	0.29
Branch length, cm	5.15	4.19	4.38	0.58
Glume interior, mm	1.95	2.00	2.00	0.15
Glume exterior, mm	2.97	3.05	3.02	0.14
P 1.	3.52	3.35	3.72	0.13
P 2.	3.52	3.25	3.80	0.10
P 3.	3.30	2.97	3.42	0.13

Comparison between the lengths of glumes in various Festuca species

Analysis of variance (Table 5) was carried out on data representing different populations originating from different habitats in order to control this characteristic as specific one. It can be stated that in most cases significance appears among the populations.

It is interesting that *Festuca pallens* and *F. vaginata* known as diploid, then *pseudovina* and *F. valesiaca* which is also supposed to be diploid (HORÁNSZKY—JANKÓ—VIDA, 1971) were the species which did not show differences

Table 4

Changes in the morphological characters of the populations at Vácrátót, in 1977 and 1978

a) *ANOVA results*

Characters		SQ	df	MQ
Panicle length	populations	258.09	3	2.70
	error	250.68	44	5.70
Internode length	populations	1.91	3	0.64
	error	51.09	56	0.91
Branch length	populations	0.27	3	0.09
	error	81.32	56	1.45
Glume interior	populations	0.85	3	0.28
	error	6.16	56	0.11
Glume exterior	populations	0.47	3	0.16
	error	7.84	56	0.14
P 1.	populations	0.41	3	0.14
	error	8.44	56	0.15
P 2.	populations	0.24	3	0.08
	error	8.13	56	0.15
P 3.	populations	0.3	3	0.10
	error	9.23	56	0.16

b) *Comparative table of means*

	V_y		V_g		S.E.
	1977	1978	1977	1978	
Panicle length, cm	10.71	10.68	10.58	9.72	0.69
Internode length, cm	3.26	3.56	3.10	3.16	0.25
Branch length, cm	4.21	4.10	4.04	4.05	0.31
Glume interior, mm	2.23	1.95	1.95	1.98	0.09
Glume exterior, mm	3.03	2.82	2.87	2.82	0.10
P 1.	3.63	3.40	3.43	3.30	0.10
P 2.	3.50	3.48	3.39	3.35	0.10
P 3.	3.07	3.18	3.18	3.27	0.10

Table 5

Analysis of variance in the length of outer glume, in the populations of Festuca species originating from different habitats

ANOVA results

Source of variation	SQ	df	MQ
Species	12.94	4	3.24
Error	17.24	60	0.29

Means:	*hirsuta*	*vaginata*	*pallens*	*valesiaca*	*pseudovina*	S.E.
	4.35	4.17	3.8	3.5	3.5	0.15

when comparisons were made among them. On this basis, the necessity of further examinations into the length of glumes as a species characteristic arises from the viewpoint whether this is indeed a specific characteristic or only one that refers to the degree of ploidy, and reflects that.

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REKONSTRUKTION DER POTENTIELLEN, PRIMÄREN ORGANISCHEN STOFFMENGE UND IHRER PRODUKTION IN UNGARN

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This paper contains the values of the one-time primary organic matter mass and the one-time production quantities, estimated for the territory of Hungary and for its small landscapes resp. The reconstruction was accomplished by means of potential vegetation maps and the estimation of production biological data of the major vegetation units. In the course of estimating the production biological data of differring vegetation units, we made use of the forestry assesments as well as of the latest Hungarian and international phytomass and production data.

In our country of 93 000 km^2 there was 494.7×10^7 t organic matter (calculated in absolute dry matter) preceding the time of anthropogenic impact. The national average of the phytomass reached 531.77 t/ha. The main causes of differences in the organic matter quantities of the various landscapes of the country can be found in the potential environmental conditions and the differring specific values of the various tree species.

The above potential organic matter supply produced yearly 17.8×10^7 t/dry matter/country. The average of production per hectar reached 19.19 t/year.

The accumulated organic matter mass of our present forests hardly reaches 4 per cent of the organic matter supply accumulated once in the Hungarian forests.

In Ungarn, bzw. in seinen ökologisch homogenen Regionen übten im wesentlichen bereits zur Zeit vor dem anthropogenen Eingriff dieselben großen Umweltfaktoren (Klima, Relief, Grundgestein, usw.) ihre Wirkung auf die Bildung von organischen Stoffen aus, wie in unseren Tagen. Infolge der andauernden dynamischen fluktuierenden Wirkung dieser Faktoren wurde das Land und seine Landschaften von einem solchen bunten Vegetationsteppich bedeckt, dessen Assoziationen auf ihrem Gebiet mittels autoregulativer Tätigkeit aufrechterhalten blieben. In den Zönosen stagnierten im allgemeinen andauernd die jeweiligen organischen Stoffmengen und die jährlich produzierten primären organischen Stoffproduktionen — abgesehen von den ständigen Änderungen der biotischen Sukzessionsprozesse. Die innerhalb der Landschaften (und des Landes) befindliche organische Stoffmenge widerspiegelte demnach jenen akkumulierten lebenslosen Umweltseinflußkomplex, als dessen Resultante die autotrophen Assoziationen ihre Vorräte an organischen Stoffen produzieren, zirkulieren, bzw. anhäufen vermochten.

Die Abschätzung der einstigen organischen Stoffmenge einer Landschaft (eines Landes) mag sehr viele Informationen zu der Umweltentwicklungs-, Umweltplanungs- und Umweltschutzarbeiten unserer Tage liefern. So muß

Tabelle 1

Fläche der ungarischen forstwirtschaftlichen Kleinlandschaften, prozentuale Verteilung der potennische Stoffproduk-

No.	Benennung d. Kleinlandschaft	Fläche d. Kleinl. in ha (Gesamtgebiet)	Prozentualer Anteil der potentiellen					
			Eichen-Zerrei.-Wald	Eichen-Hainbuchen-Wald	Auenwald	Tataren ahorn-E. Wald	Buchen-Wald	geschl. Sand-Wälder
1.	Szatmár-Bereger Flachland	168 611	—	10	72	—	—	—
2.	Nyírség	510 600	—	5	14	—	—	65
3.	Nagykun-Hajdúhát (Hortobágy)	880 637	—	—	25	25	—	—
4.	Körösgegend	223 859	—	—	60	5	—	—
5.	Békéser-Rücken	114 582	—	—	5	20	—	—
6.	Csanáder-Rücken	459 986	—	—	15	20	—	—
7.	Überschwemmungsgeb. d. Theiß, usw.	183 010	—	—	85	—	—	—
8.	Sandrücken im Donau—Theiß Zwischenstromland	986 340	—	—	15	—	—	25
9.	N-Bácskaer Lößrücken	93 364	—	—	—	15	—	—
10.	Donautal (Alkaliböden d. Kiskunság)	178 968	—	—	40	—	—	10
11.	Mittleres u. unteres Donau Überschwemmungsgebiet	200 520	—	—	80	—	—	—
12.	Gödöllőer Hügelland	106 556	60	10	5	15	—	5
13.	Jászság	41 744	—	—	10	35	—	25
14.	Vorland d. Mátra—Bükk Geb.	371 809	10	—	40	35	—	5
15.	Sátor-Gebirge	96 111	34,5	20	—	—	15	—
16.	Borsoder Hügelland, Cserehát	344 427	80	10	5	3	—	—
17.	Aggteleker Karstgebiet	31 062	30	37	—	—	1	—
18.	Bükk-Gebirge	82 162	30	23	—	—	36	—
19.	Hügelland von Heves	111 397	55	17	5	15	3	5
20.	Mátra-Gebirge	96 968	45	30	—	—	15	—
21.	Cserhát	215 122	90	5	2,5	—	0,5	—
22.	Börzsöny-Gebirge	62 802	60	22	0,5	—	10	—
23.	Dunazug—Gerecse-Gebirge	212 558	62	15	2	—	5	—
24.	Sandgebiet im Kleinalföld	141 776	5	—	5	15	—	25
25.	Vértes-Gebirge	47 193	35	16	—	—	7,5	—
26.	Sukoró	11 111	70	—	—	10	—	—
27.	Mezőföld	400 458	5	—	15	50	—	—
28.	Sandgebiet von Tengelic	64 852	10	—	—	10	—	—
29.	Außen-Somogy, Tolnaer Bergrücken	547 155	45	20	4	5	1	—
30.	Villányer Gebirge	16 682	50	25	—	—	—	—
31.	Ormánság	133 503	—	25	68	—	—	—
32.	Mecsek-Gebirge	68 995	25	59	—	—	10	—
33.	Zselicség	139 341	30	50	2	—	17	—
34.	Inner-Somogy	252 076	20	41,5	10	—	—	20
35.	Klein-Balaton, Tapolcaer Becken	61 881	—	—	—	—	—	—
36.	Rücken von Zala	173 120	20	40	8	—	25	2
37.	Buchenlandschaft von Göcsej	74 167	10	19	10	—	55	—
38.	Nadelholzregion von Göcsej	45 260	20	15	10	—	5	—
39.	Őrség	75 590	—	15	10	—	—	—
40.	Vas—Zalaer Bergrücken	191 103	—	50	10	—	32	—
41.	Vorland d. Bakony, Balatonoberland	212 321	50	10	—	—	4,8	—
42.	Hoch-Bakony-Gebirge	134 653	19	25	—	—	50	—

tiellen Vegetationseinheiten und die durchschnittliche potentielle organische Stoffmenge, bzw. orga-tion pro Hektar

Vegetationseinheiten innerhalb der forstwirtschaftlichen Landschaft										Durchschnittl. potentielle	
offene Sand-Wälder	Flaum-eichen-Wälder	Kiefern-Wälder	Fichten-Wald	Moor-Erlen-Wälder	Azi-doph. Wälder	Steppe	alkali Rasen	Wasser-Sumpf-Veg.	Felsen	Phytomasse, t/ha	Produktion, t/ha/Jahr
										der Kleinlandschaften	
—	—	—	—	12	—	—	—	6	—	546,3	17,38
10	—	—	—	4	—	—	—	2	—	644,9	19,6
—	—	—	—	—	—	20	25	5	—	347,6	16,5
—	—	—	—	10	—	—	20	5	—	438,3	14,9
—	—	—	—	—	—	60	15	—	—	199,6	18,35
—	—	—	—	—	—	50	15	—	—	256,4	18,25
—	—	—	—	5	—	—	—	10	—	526,0	17,35
40	—	—	—	10	—	5	3	2	—	428,3	17,34
7	—	—	—	—	—	75	3	—	—	153,67	19,9
—	—	—	—	20	—	—	20	10	—	398,5	13,5
—	—	—	—	—	—	—	—	20	—	475,8	16,4
—	5	—	—	—	—	—	—	—	—	662,3	22,65
25	—	—	—	—	—	5	—	—	—	584,6	20,79
—	—	—	—	—	—	—	10	—	—	610,4	19,85
—	15	—	—	—	15	—	—	—	0,5	697,4	22,6
—	2	—	—	—	—	—	—	—	—	656,1	23,2
—	25	—	—	2	—	—	—	—	5	597,6	22,08
—	3	—	—	0,5	7	—	—	—	0,5	683,3	20,55
—	—	—	—	—	—	—	—	—	—	682,0	22,63
—	6	—	—	1	3	—	—	—	—	665,5	21,4
—	2	—	—	—	—	—	—	—	—	653,7	23,57
—	7	—	—	0,5	—	—	—	—	—	663,2	22,29
—	15	—	—	—	—	—	—	—	1	639,4	22,42
50	—	—	—	—	—	—	—	—	—	500,6	19,5
—	35	—	—	1,5	—	—	—	—	5	589,9	20,83
—	—	—	—	—	20	—	—	—	—	626,7	22,23
—	—	—	—	5	—	22	—	3	—	534,3	21,2
80	—	—	—	—	—	—	—	—	—	361,08	18,4
2	22	—	—	1	—	—	—	—	—	628,1	22,06
—	25	—	—	—	—	—	—	—	—	630,9	22,2
—	—	—	—	5	—	—	—	2	—	594,2	18,39
—	3	—	—	—	3	—	—	—	—	671,6	20,32
—	—	1	—	—	—	—	—	—	—	685,1	20,55
—	—	—	—	8	—	0,5	—	—	—	656,0	19,85
—	—	—	—	70	—	—	—	30	—	300,3	10,2
—	—	—	—	5	—	—	—	—	—	681,0	19,95
—	—	3	—	3	—	—	—	—	—	709,9	19,47
—	—	45	—	5	—	—	—	—	—	569,4	17,0
—	—	60	—	5	10	—	—	—	—	516,7	14,64
—	—	3	—	5	—	—	—	—	—	683,7	18,79
—	35	—	—	0,2	—	—	—	—	—	621,0	22,58
—	5	0,5	—	0,5	—	—	—	—	—	715,4	19,26

Tabelle 1 (Fortsetzung)

No.	Benennung d. Kleinlandschaft	Fläche d. Kleinl. in ha (Gesamtgebiet)	Prozentualer Anteil der potentiellen					
			Eichen-Zerrei.-Wald	Eichen-Hainbuchen-Wald	Auenwald	Tataren ahorn-E. Wald	Buchen-Wald	geschl. Sand-Wälder
43.	Nordlicher Pannon-Rücken	217 718	65	20	8	4	—	—
44.	Kemenesalja	187 945	70	10	7	3	—	—
45.	Hügelland von Vas	70 149	5	50	—	—	10	—
46.	Vorland d. Írottkő-Gebirges	49 115	7	40	—	—	10	—
47.	Soproner Berggegend	9 109	—	50	—	—	20	—
48.	Soproner Hügelland	33 497	50	20	—	—	—	—
49.	Hanság	107 043	—	—	40	—	—	—
50.	Szigetköz	64 046	—	—	85	—	—	—

z. B. der Mensch imstande sein, die primäre organische Stoffproduktion der ursprünglichen autoregulativen Ökosysteme an ihren heutigen Orten mittels guter Organisation der Produktionskräfte, einer richtigen Entwicklung der Technik und Technologie der Produktion, und nicht zuletzt mittels der Verwirklichung der aufgrund der ökologischen Kenntnis herausgebildeten Assoziations- (Ökosystemen) -regulation bedeutend zu erheben, und dies ohne die Belastung der Umgebung und ohne eine Umweltschädigung.

Gang der Rekonstruktion des potentiellen organischen Stoffes und der primären Produktion

Die Abschätzung des — der anthropogenen Tätigkeit vorangehenden — sog. potentiellen organischen Stoffvorrats und der primären Produktion auf regionalem, bzw. Landesniveau erfordert einen mehrstufigen Arbeitsprozess. Im folgenden geben wir die einzelnen Phasen solcher Arbeiten in Ungarn bekannt, mittels deren die organischen Stoffmengen, bzw. die Produktionsmengen der Landschaften und des Landes abgeschätzt wurden.

1. Es ist eine grundlegende Notwendigkeit, daß als Synthese der früheren phytozönologischen Forschungen eine potentielle (rekonstruierte) Vegetationskarte uns zur Verfügung stehen soll. Im Falle von Ungarn veröffentlichte Zólyomi (1967) eine moderne potentielle Vegetationskarte im Maßstab von 1 : 1 500 000. Die auf dieser angegebenen phytozönologischen Einheiten bildeten im wesentlichen die Grundlagen zu den untenstehenden Abschätzungen. Außer der Zólyomischen Vegetationskarte haben wir auch die in Manuskript befindlichen Blätter der von Jakucs redigierten (1969) potentiellen Vegetationskarte im Maßstab von 1 : 200 000 angewandt.

2. In Ungarn wurden mehrere Landschaftsaufteilungen verfertigt (s. z. B. Pécsi, Somogyi und Jakucs, 1972). Aus praktischen Gründen haben wir jedoch in unserer Rekonstruktionsarbeit die aufgrund der Arbeiten von Bulla und Babos zusammengestellten forstwirtschaftlichen Landschaften benutzt (s. Danszky, 1964; Keresztesi, 1971). Aufgrund des Aufeinanderlegens der forstwirtschaftlichen Landschaftskarte — auf der die genauen Hektarflächen angegeben sind —, sowie der potentiellen Vegetationskarte konnte mit guter Genauigkeit abgeschätzt werden, welchen Prozentwert die einstigen Pflanzenassoziationen innerhalb der Kleinlandschaften zeigten (Tabelle 1). Diese Daten führten dazu, daß wir innerhalb der

Vegetationseinheiten innerhalb der forstwirtschaftlichen Landschaft										Durchschnittl. potentielle	
offene Sand-Wälder	Flaum-eichen-Wälder	Kiefern-Wälder	Fichten-Wald	Moor-Erlen-Wälder	Azi-doph. Wälder	Steppe	alkali Rasen	Wasser-Sumpf-Veg.	Felsen	Phytomasse, t/ha	Produktion, t/ha/Jahr
										der Kleinlandschaften	
—	2	1	—	—	—	—	—	—	—	656,5	22,45
—	—	—	—	—	10	—	—	—	—	636,8	22,25
—	—	22	3	—	10	—	—	—	—	615,3	17,4
—	—	25	5	—	13	—	—	—	—	598,1	17,1
—	—	—	5	—	25	—	—	—	—	631,6	17,8
—	20	—	—	—	—	—	—	10	—	571,1	20,8
—	—	—	—	50	—	—	—	10	—	450,9	14,2
—	—	—	—	5	—	—	—	10	—	526,0	17,3

Landschaften die Hektarenwerte der einstigen Assoziationen, bzw. die Verbreitung der einzelnen Gesellschaften auch in Hinsicht auf das ganze Land summieren konnten. Die senkrecht schraffierten, liegenden Kolumnen zeigen die prozentuale Flächenverteilung der einstigen potentiellen Vegetation auf dem ganzen Gebiet von Ungarn an (Summe der Kolumnen: 100% = 93 000 km²). Die sich an die Kolumnen anschließenden stärker schraffierten Rechtecke geben die heutigen Reste der ursprünglichen Vegetationseinheiten an, natürlich sind diese meistens regulierte Assoziationen.

Dem Abbild ist zu entnehmen, daß in der einstigen Vegetation Ungarns die verschiedenen Wälder vorherrschten (86%) und das Flächenverhältnis der baumfreien Gebiete (vor allem Lößsteppen und Wasservegetation) nur 13% ausmachen mochte. Das Abbild bezeugt gleichzeitig, daß ein großer Teil Ungarns zu der mediterranen Laubwaldzone gehörte.

3. Eine folgende Phase der Rekonstruktion der potentiellen organischen Stoffmenge besteht in der quantitativen Abschätzung der einstigen durchschnittlichen Phytomasse und

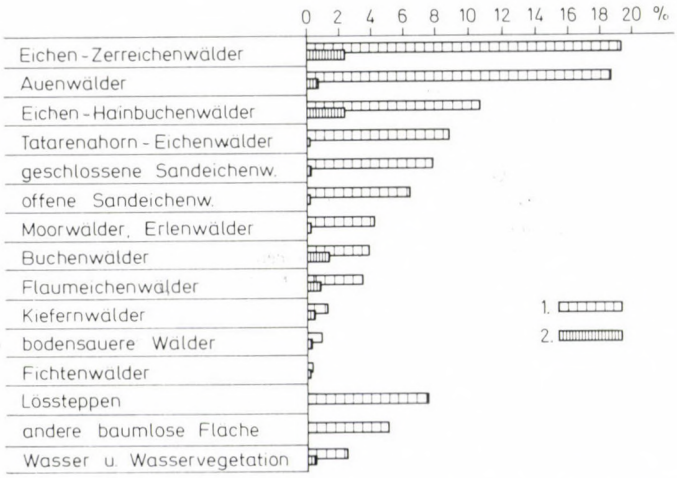

Abb. 1. Flächenprozente (= 100%) der selbstregulativen (potentiellen) Phytozönosen (1) Ungarns; ferner die Verteilung ihrer heutigen naturnahen Reste (2 = 9.38%) aufgrund der Daten von 1960 (orig.)

der durchschnittlichen Phytomassenjahresproduktion der einzelnen getrennten Vegetationseinheiten. Die größte Schwierigkeit besteht bei dieser Abschätzung darin, daß wir heute sozusagen über keine solchen Assoziationsbestände ursprünglichen Typs verfügen (Urwald-, Ursteppen-, Ursumpf- usw. Charakter), die damals vorzufinden waren, als der Mensch noch keinerlei Regulationen in ihnen vorgenommen hatte.

Da unsere meisten potentiellen heimischen Zönosen Wälder waren, mußte ihre Abschätzung mit der größten Sorgfalt durchgeführt werden. Es bedeutete eine Hilfe, daß man aus den heutigen, alten, naturnahen Waldresten auf die durchschnittlichen Baumartmischverhältnisse, die Entwicklungsstufe der Strauch- und Krautschicht, usw. schließen kann. Als Ausgangspunkt wurde die Hypothese angenommen, daß die überirdische Holzmasse der urwaldartigen Wälder im wesentlichen mit der totalen Holzmasse der heute 100 Jahre alten Bestände übereinstimmen mag. Bei den untenstehenden Arten wurden aus den Holzproduktionstafeln der von SOPP (1974) redigierten Holzmassenrechnungstabellen — immer mit Bezug auf die III. Holzertragsklasse und den Samenursprung — die Holzmasse der totalen Holzproduktion je Hektar, und das durchschnittliche Wachstum für 100 Jahre festgestellt: Stieleiche (*Quercus robur*), Steineiche (*Quercus petraea*), Zerreiche (*Quercus cerris*), Flaumeiche (*Quercus pubescens*) die Holzmasse für 60 Jahre und das Holzwachstum für 100 Jahre festgestellt, Buche (*Fagus silvatica*), Hainbuche (*Carpinus betulus*), Erle (*Alnus glutinosa*), Hochesche (*Fraxinus excelsior*, *F. angustifolia*), Kiefer (*Pinus silvestris*), Fichte (*Picea abies*), Pappel (*Populus alba*, *P. nigra:* für 40 Jahre festgestellt), Feldulme und Feldahorn (*Ulmus campestre*, *Acer campestre*), Weide (*Salix* sp.: für 40 Jahre bestimmt), Birke (*Betula pendula*) für 60 Jahre festgestellt.

Die Daten für m^3/ha der Holzproduktionstabellen mit den von KOLLMANN, FABRICIUS, KRIPPEL (in BÉKY, 1956) angegebenen absoluten Trockenwichtenwerten multipliziert, haben wir die t/ha-Gewichte der oberirdischen Holzphytomasse erhalten.

Im weiteren wurden — dem Baumartenmischverhältnis der einzelnen Assoziationen entsprechend — die oberirdische Holzphytomasse je Durchschnittshektar der Assoziation, bzw. das jährliche Wachstum derselben berechnet. Bei den einzelnen Assoziationen wurden als Baumartenmischverhältnis folgende Prozentwerte angenommen:

— **Eichen-Zerreichenwälder** (*Quercetum petraeae-cerris*, *Tilio argenteae-Quercetum*, *Potentillo albae-Quercetum*, usw.): *Quercus petraea* 60%, *Qu. cerris* 40%.

— **Eichen-Hainbuchenwälder** (*Querco petraeae-Carpinetum*, *Querco robori-Carpinetum*, usw.): *Quercus petraea* 70%, *Carpinus betulus* 30%.

— **Auenwälder** (*Fraxino-Ulmetum*, *Salicetum albae-fragilis*, usw.): *Quercus robur* 40%, *Fraxinus* 30%, *Populus* 20%, *Salix* 10%.

— **Tatarenahorn-Eichenwald** (*Aceri tatarici-Quercetum*, *Galatello-Quercetum*): *Quercus robur* 30%, *Qu. petraea* 30%, *Qu. cerris* 30%, *Qu. pubescens* 10%.

— **Buchenwälder** (*Melitti-Fagetum*, *Aconito-Fagetum*, usw.): *Fagus* 100%.

— **Geschlossene Sandeichenwälder** (*Convallario-Quercetum*): *Quercus robur* 85%, *Fraxinus* 15%.

— **Offene Sandeichenwälder** (*Festuco-Quercetum*, *Junipero-Populetum*): *Quercus robur* 25%, *Populus* 20%.

— **Flaumeichenwälder** (*Orno-Quercetum*, *Corno-Quercetum*, *Cotino-Quercetum*, usw.): *Quercus pubescens* 100%.

— **Kiefernwälder** (*Myrtillo-Pinetum*, *Festuco-Pinetum*): *Pinus silvestris* 100%.

— **Fichtenwälder** (*Abieto-Piceetum*): *Picea* 100%.

— **Moorwälder-Erlenwälder** (*Dryopteridi-Alnetum*, *Alnetum glutinosae-incanae*, usw.): *Alnus* 100%.

— **Bodensauere Wälder** (*Genisto tinctoriae-Quercetum* s. l.): *Quercus petraea* 70%, *Carpinus betulus* 20%, *Betula* 10%.

Tabelle 2

Abgeschätzte Phytomasse der potentiellen Vegetationseinheiten und ihre Jahresproduktion in t/ha

Vegetationseinheit	Phytomasse					Total	Produktion					Total
	überirdische holzige Teile	unterirdische Teile (Wurzel)	Laub (Baum)	Strauch	Krautartige Pflanzen		überirdische holzige Teile	unterirdische Teile (Wurzel)	Laub (Baum)	Strauch	Krautartige Pflanzen	
Eichen-Zerreichenwälder	628,49	157,12	6,67	5	1	656	6,67	7,85	6,67	1,8	1	24
Eichen-Hainbuchenwälder	533,59	133,40	5,34	5,5	0,5	678	5,34	6,67	5,34	1,6	0,5	19
Auenwälder	447,88	89,58	5,74	10,0	1,5	593	5,74	4,48	5,74	2,0	1,5	19
Tatarenahorn-Eichenwälder	601,91	150,48	6,51	12,0	0,5	771	6,51	7,53	6,51	3,0	0,5	24
Buchenwälder	643,77	128,75	6,42	1,0	0,3	780	6,42	6,44	6,42	0,1	0,3	20
Geschlossene Sandeichenwälder	581,95	145,49	5,87	10,0	0,5	744	5,87	7,28	5,87	1,0	0,5	21
Offene Sandeichenwälder	204,72	51,19	2,83	3,0	11,0	273	2,83	2,56	2,83	0,3	8,8	17
Flaumeichenwälder	396,80	119,04	6,14	10,0	2,0	534	6,14	5,95	6,14	2,0	2,0	22
Kiefernwälder	397,88	79,58	3,97	0,5	0,5	482	3,97	3,98	3,97	0,1	0,5	13
Fichtenwälder	390,87	78,17	3,91	—	0,2	473	3,91	3,91	3,91	—	0,2	12
Moor- und Erlenwälder	324,87	97,46	3,23	0,5	0,2	426	3,23	4,88	3,23	0,1	0,2	12
Azidophile Wälder	357,60	89,40	5,28	—	0,2	452	5,28	4,47	5,28	—	0,2	15
Steppenwiesen	—	—	—	—	25,0	25	—	—	—	—	20,0	20
Alkali-Steppen	—	—	—	—	5,0	5	—	—	—	—	4,0	4
Wasser- u. Sumpfvegetation	—	—	—	—	7,0	7	—	—	—	—	6,0	6
Felsen, kahle Flächen, usw.	—	—	—	—	1,0	1	—	—	—	—	1,0	1

Die Abschätzung der unterirdischen Phytomasse wurde aufgrund der Erfahrungen von produktionsbiologischen Arbeiten, ferner der forstlichen Praxis entsprechend durchgeführt. Die Phytomasse unter der Schlagfläche + die unterirdische Phytomasse machen im allgemeinen 20—25% der oberirdischen Holzphytomasse aus.

Aufgrund der produktionsbiologischen Messungen haben wir die Laubphytomasse der Assoziationen einheitlich mit dem Laubproduktionswert als identisch betrachtet (s. unten). Das Gesamtgewicht der Sträucher (Blatt + Ast + Wurzel) wurde mittels Erfahrungsschätzungen und aufgrund des Vergleichs mit den gemessenen Daten abgeschätzt. Mit Hilfe ähnlicher Methoden haben wir auch das Gewicht der Krautphytomasse je Hektar erhalten (s. JAKUCS red. 1979 mscr.).

Bei der Abschätzung der Jahresproduktion wurde das Wachstum der oberirdischen Holzteile aufgrund der Holzmassentabellen berechnet. Wir haben die Laubproduktion mit dem jeweiligen Jahreswachstum als identisch betrachtet. Die jährliche Wurzelproduktion wurde auf 5% der Wurzelphytomasse geschätzt, wobei auch die jährlich in bedeutender Masse produzierten und absterbenden Haarwurzeln und das dünne Wurzelwerk berücksichtigt wurde. Die Strauchproduktion betrug 10—20% (je nach Assoziation) der Strauchphytomasse, die Produktion der Krautschicht war mit der Krautphytomasse identisch.

Obige Berechnungen und Abschätzungen sind in Tabelle 2 dargestellt. Hier werden auch die absoluten Trockengewichte des als durchschnittlich angenommenen, summierten potentiellen organischen Materials und der Produktion je Hektar in den einzelnen Assoziationen angegeben; die endgültigen Werte sind auf ganze Zahlen ergänzt worden. In derselben Tabelle sind auch die abgeschätzten Gewichte je Hektar der vier baumfreien Assoziationskomplexe vorzufinden (bei ihrer Feststellung wurden die heimischen und internationalen produktionsbiologischen Ergebnisse weitgehend berücksichtigt).

4. Wir haben die potentiellen Gewichtsdaten der Assoziationen mit den Hektarwerten der sich innerhalb der einzelnen Landschaften zeigenden Flächenanteilen multipliziert. Diese Summe wurde mit der Hektarfläche der Landschaft dividiert und als Ergebnis erhielten wir

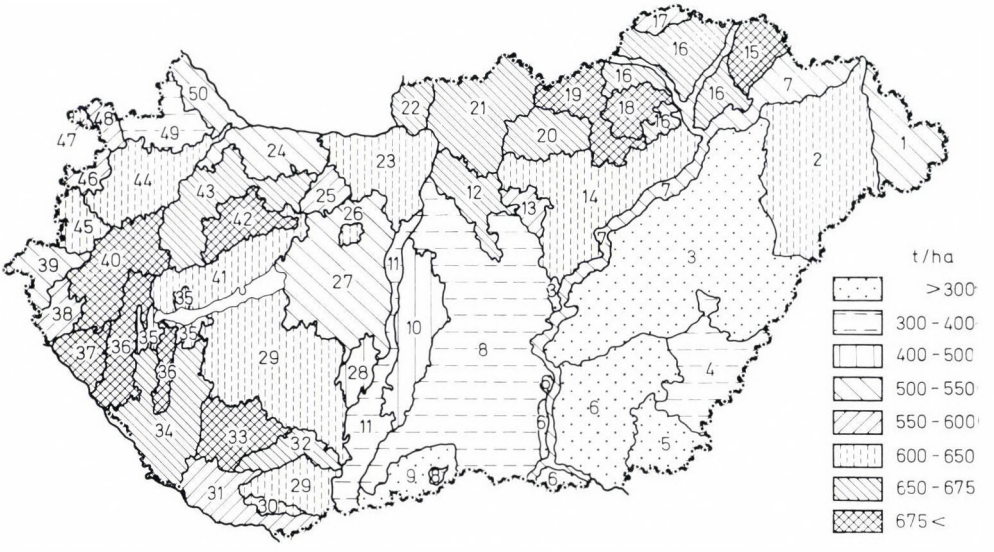

Abb. 2. Durchschnittlicher potentieller organischer Stoffvorrat der ungarischen forstwirtschaftlichen Kleinlandschaften — t/ha/Trockensubstanz (orig.)

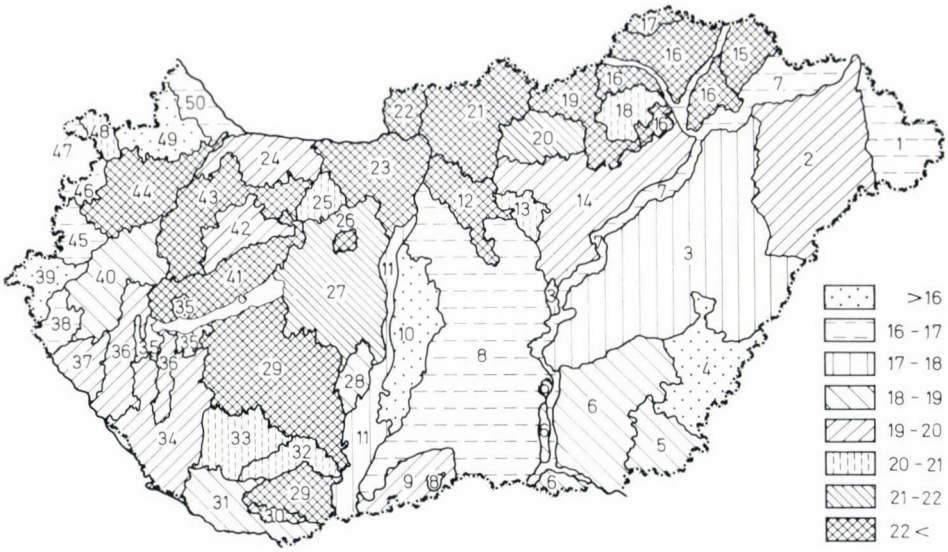

Abb. 3. Durchschnittliche potentielle organische Stoffproduktion der ungarischen forstwirtschaftlichen Kleinlandschaften (t/ha/Trockensubstanz/Jahr) (orig.)

die durchschnittliche potentielle Phytomassen-, bzw. Produktionsmenge der einzelnen forstwirtschaftlichen Landschaften. Die Ergebnisse sind in Tabelle 1 veröffentlicht worden und ihre graphische Darstellungen in den Abbildungen 2—3 vorzufinden.

5. Als letzte Phase der Abschätzungsarbeit haben wir aufgrund des Resultats der im Landesmaßstab summierten Hektarfläche der einzelnen Assoziationen und des durchschnittlichen Phytomassen-, bzw. Produktionsgewichts der Gesellschaften feststellen können, wie sich im Lande innerhalb der Assoziationen der Vorrat an organischen Stoffen verteilt. Die Summierung dieser letzteren hat die potentielle organische Stoffmenge des ganzen Landes, bzw. seine Produktionsmenge in absolutem Trockengewicht angegeben (Tabelle 3).

Wichtigste Ergebnisse

Das akkumulierte primäre organische Material

Auf dem Gebiet von Ungarn akkumulierte sich vor dem anthropogenen Eingriff mit einer andauernden dynamischen Stagnierung insgesamt $494{,}7 \times 10^7$ t organisches Material (in absolutem Trockengewicht). Diese primäre Menge an organischen Stoffen befand sich zu 99,58% in den Wäldern des Landes und nur zu 0,42% auf baumfreiem Gebiet. Der Landschaftsdurchschnitt der Phytomasse per Hektar war 531,77 t/ha, an den Waldflächen 604,13, auf den baumfreien Gebieten 18,25 t/ha.

Unter den Assoziationen häufte sich — das ganze Land betreffend — das meiste organische Material in den Eichen-Zerreichenwäldern und in den

Tabelle 3

Potentieller organischer Stoffvorrat Ungarns und Produktion in den Wäldern und baumfreien Vegetationseinheiten

	Potentielle Fläche, ha		Phytomasse, tausend t		Produktion, tausend t/Jahr	
Wälder						
Eichen-Zerreichenwälder	1 813 291		1 189 519		43 519	
Auenwälder	1 736 671		1 029 846		32 997	
Eichen-Hainbuchenwälder	991 330		672 122		18 835	
Tatarenahorn-Eichenwälder	818 836		631 322		19 652	
Geschlossene Sandeichenwälder	725 617		539 859		15 238	
Offene Sandeichenwälder	597 540		163 128		10 158	
Moor- und Erlenwälder	389 595		165 967		4 675	
Buchenwälder	358 530		279 653		7 171	
Flaumeichenwälder	318 493		170 075		7 007	
Kiefernwälder	105 635		50 916		1 373	
Acidophile Wälder	69 400		31 389		1 041	
Fichtenwälder	5 015		2 372		60	
Potentielle Wälder, total	8 154 127	(87,65%)	4 926 168	(99,58%)	161 726	(90,55%)
Baumfreie Assoziationen						
Steppenwiesen	684 399		17 110		13 688	
Alkali-Steppen	456 481		2 282		1 826	
Wasser- u. Sumpfvegetation	225 290		1 577		1 352	
Felsen, Kahle Flächen, usw.	6 931		7		7	
Potentielle baumfreie Assoziationen, total	1 148 927	(12,35%)	20 976	(0,42%)	16 873	(9,45%)
Total	9 303 054	(100,00%)	4 947 144	(100,00%)	178 599	(100,00%)

Auenwäldern an ($118{,}9 \times 10^7$, bzw. $102{,}9 \times 10^7$ t). Die Phytomasse der baumfreien Assoziationen war der Größenordnung nach geringer als die der Waldassoziationen.

Was die Landschaftsverteilung anbelangt, so war die auf ein Hektar fallende Phytomasse in der mittleren Regionen der Großen Ungarischen Tiefebene (forstwirtschaftliche Kleinlandschaften Nr. 1—14, 27—28, 31) am kleinsten (444,71 t/ha). Von den Kleinlandschaften zeigten besonders die einstigen Lößsteppengebiete (Rücken von Békés, Csanád, Nordbácska, usw.) sehr niedrige Gesamtphytomassenwerte. Von den mittelgroßen Landschaften machte die durchschnittliche Phytomasse der Kleinen Tiefebene (Kisalföld) (Kleinlandschaften Nr. 24, 44, 49—50) 544,34 t/ha, die des Transdanubischen

Hügellandes (Kleinlandschaften Nr. 29—30, 32—35) 626,02 t/ha, die des Alpenvorlandes (Kleinlandschaften Nr. 36—40, 45—48) 642,69 t/ha, die des Transdanubischen Mittelgebirges (Kleinlandschaften Nr. 23, 25, 26, 41—43) 648,46 t/ha und die des Nordungarischen Mittelgebirges (Kleinlandschaften Nr. 12, 15—22) 663,75 t/ha aus. Die Daten weisen darauf hin, daß das durchschnittliche Trockengewicht des primären organischen Stoffes je Hektar in jenen Hügel- und Berglandschaften am höchsten war, wo Hartholzwälder bestanden (Eiche, Buche, Hainbuche, usw.), im Gegensatz zu den Gebieten in Westungarn, wo Weichholzwälder (Kiefer, Fichte), bzw. auf den Überschwemmungsgebieten, wo ebenfalls Weichholzwälder (Pappel, Weide, usw.) wuchsen.

Wir erwähnen aus Vergleichszwecken, daß nach SALI (1979) der gesamte heutige Holzvorrat in Ungarn (Situation am 1. 1. 1976) $23{,}8 \times 10^7$ m^3, bzw. aufgrund der Multiplizierung mit dem absoluten speziellen Trockengewicht der einzelnen Baumarten $19{,}6 \times 10^7$ t/Land beträgt (kaum 4% des in den einstigen Wäldern akkumulierten organischen Stoffes). Diese Baummasse lebt auf einem Gebiet von 1 490 000 ha, der durchschnittliche Gehalt an organischen Stoffen unserer heutigen Wälder machen also per Hektar 131,60 t aus (im Verhältnis zu den potentiellen Wäldern etwa 22%).

Produktion

Der oben beschriebene potentielle Vorrat an organischen Stoffen produzierte (richtiger gesagt umsetzte) jährlich $17{,}8 \times 10^7$ t/Trockensubstanz/Jahr /Land. 90,55% der Produktion wurde in den Wäldern und 9,45% in den baumfreien Assoziationen erzeugt. Die durchschnittliche Produktion je Hektar war im Landesmaßstab 19,19 t/Jahr, im Durchschnitt der Wälder 19,83, in dem der baumfreien Assoziationen 14,68 t/ha/Jahr.

Von den Assoziationen wurde jährlich das meiste organische Material von den Eichen-Zerreichenwäldern, den Tatarenahorn-Eichenwäldern und den Flaumeichenwäldern produziert, aber die jährliche Produktion an organischen Stoffen war in den Lößsteppen höher als in zahlreichen Wäldern (s. Tabelle 2).

Die quantitative Reihenfolge der durchschnittlichen Produktion je Hektar stimmt in den mittelgroßen und kleinen Landschaften des Landes mit der Reihenfolge der organischen Stoffmengen nicht überein. Das ist hauptsächlich darauf zurückzuführen, daß die Produktion an organischen Stoffen der grasigen Urrasen hohe Werte zeigte. Es gab Kleinlandschaften (s. z. B. die Rücken von Békés, Csanád, Bácska), deren gesamter Vorrat an potentiellen organischen Stoffen sehr niedrig war, die aber eine höhere Jahresproduktion als die durchschnittliche Produktion zahlreicher bewaldeten Kleinlandschaften zeigten. In der Zusammenfassung der mittelgrossen Landschaften zeigte sich folgende wachsende Reihenfolge in Hinsicht auf die Durchschnittsproduktio-

nen: Große Ungarische Tiefebene 17,77, Alpenvorland 18,42, Kleine Ungarische Tiefebene (Kisalföld) 19,12, Transdanubisches Hügelland 20,57, Transdanubisches Mittelgebirge 21,87 und Nordungarisches Mittelgebirge 22,69 t/ha/Jahr. Bei den bewaldeten Kleinlandschaften können die Unterschiede in der Produktion großenteils auf die Wichtenverhältnisse der waldbildenden Bäume zurückgeführt werden (Hartholzwälder, Weichholzwälder).

Die sich in den potentiellen organischen Stoffvorräten und den potentiellen Produktionen zwischen den einzelnen Landschaften zeigenden Unterschiede ermahnen uns an die Möglichkeiten, die im ökologischen Charakter der gegebenen Landschaften bestehen und auch in wirtschaftlicher Hinsicht berücksichtigt werden sollten.

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NÄHRSTOFFAKKUMULATION BEI WASSERMAKROPHYTEN

Von

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Die Autoren untersuchten die Wirkung der Konzentrationsänderung der Biogenelemente im Standort (Wasser) auf die Konzentrationsänderung der Biogenelemente in den einzelnen Organen der Pflanzen am Beispiel von *Nuphar lutea*. Es wurde die Korrelation zwischen den Biogenelementen und ihrem Gehalt in den Pflanzen festgestellt. Durch lineare Regressionsrechnung wurde die positive bzw. negative Wechselwirkung der akkumulierten Biogenelemente in den Pflanzen bestimmt.

Einführung

Das auf der Tagesordnung stehende Problem eines wirksamen Gewässerschutzes, ist in den letzten Jahrzehnten die Bewertung des Einflusses des intensiven Pflanzenbaus auf die Wasserqualität, sowie die Reduzierung dessen ungünstiger Wirkung. Das erscheint beim Plattensee von größter Bedeutung, weil man nicht vergessen soll, daß in diesem Raum, besonders im Keszthelyer und Szigligeter Becken eine beachtliche landwirtschaftliche Einwirkung vorhanden ist.

Mit der Keszthelyer-Bucht hängt geographisch das westliche Becken des Plattensees, der sogenannte »Kisbalaton« zusammen. Die Zala fließt durch dieses ehemalige Sumpfgebiet, und lagerte die mitgeschleppten Einwaschungen ab. Große Bedeutung hat hier die Menge der ins Wasser gelangenden (Makro- und Mikro-) Nährstoffe.

In den letzten 15 Jahren wurden unsere Forschungsergebnisse zu diesem Thema in mehreren Studien veröffentlicht. Die Probleme der Nährstoffanreicherung in Wassermakrophytenarten wurden oft auch auf Symposien und auch auf Kongressen diskutiert. Bisher hatten wir unsere Ergebnisse nicht mit einer matematischen Formel ausgewertet. Auf Grund unserer Daten vom Sommer (Ende Juli) 1978 möchten wir für die in unserem Wasserökosystem charakteristische *Nuphar lutea* die mathematische Auswertung zeigen.

Methoden und Auswertung

Das Material wurde von *Nupharo-Castalietum* Gesellschaften aus dem Kisbalaton entnommen. Unsere Daten beziehen sich auf 48 Probenentnahmen. Wir untersuchten die Biogenelementkonzentration im Standort (Wasser) und in den Organen der *Nuphar lutea* (Wurzel, Rhizom, Stengel, Blatt).

Die folgenden Biogen-Elemente wurden von uns gemessen: ges. N, ges. P, Na, K, Ca, Mg, Mn, Fe, Cu. Hier möchten wir nicht auf die Details der Untersuchungsmethoden eingehen, nur mit einigen Worten das Prinzip der

Messungen behandeln. Der Gesamt-N-Gehalt wurde mit der Kjeldahl-Methode, der Gesamt-P-Gehalt spektrophotometrisch gemessen. Für die Bestimmung von K, Na, Ca benutzten wir das Flammenphotometer (Flapho 4). Mit dem Atomabsorbtionsflammenphotometer (AAS_1) bestimmten wir die folgenden Elemente: Mg, Zn, Mn, Fe, Cu.

Den Zusammenhang zwischen dem Biogenelementgehalt des Standortes (Wasser) und dem Biogenelementgehalt in den einzelnen Organen (Wurzel, Rhizom, Stengel, Blatt) von Nuphar lutea stellten wir durch lineare Regressionsrechnung mit zwei Veränderlichen nach der folgenden Formel fest:

$$Y = a + bx$$

Dabei bedeutet:

Y = errechneter Wert (aktueller Biogenelementgehalt in der Pflanze mg/100 g Trockensubstanz).

a = theoretischer Wert für den Biogenelementgehalt in den Pflanzen, wenn der Biogenelementgehalt des Standortes (Wasser) Null ist.

b = Veränderung des Biogenelementgehaltes (ppm) in den Pflanzen, die durch Veränderung des Biogenelementgehaltes im Standort (Wasser) hervorgerufen wird.

x = aktueller Biogenelementgehalt des Standortes (Wasser) in ppm.

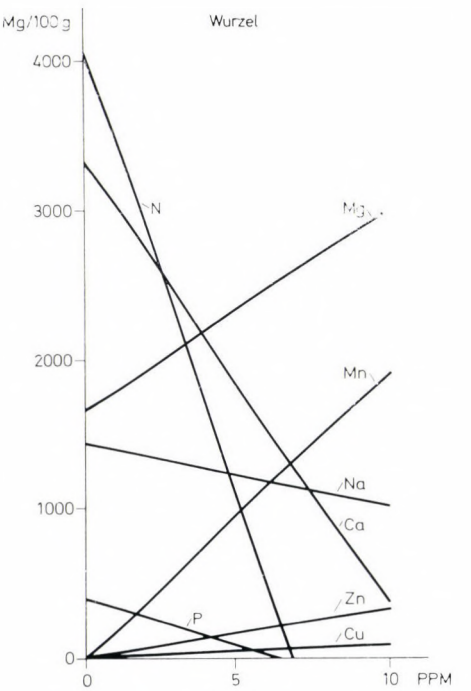

Abb. 1.

Mit Hilfe dieses Zusammenhanges können wir voraussagen in welchem Maße sich die Akkumulation der einzelnen Biogenelemente in Abhängigkeit von der Konzentration der Biogenelemente im Wasser verändern, wenn wir für x den aktuellen Biogenelementgehalt des Wassers einsetzen.

Diese Beziehungen begrenzen im Voraus die anorganische Nährstoffaufnahme der Pflanzen. Diese Gesetzmäßigkeit ist jedoch, oberhalb bestimmter Konzentrationsgrenzen nicht mehr gültig. Die auf Grund von Biogenelementkonzentrationsveränderungen im Wasser (in ppm) auftretende Anreicherung bzw. Verarmung des betreffenden Biogenelementes in den Pflanzen zeigen für die einzelnen Organe die folgenden Tabellen und Abbildungen (1—4):

Elemente	Wurzel $Y =$	Rhizom $Y =$
N	$4062{,}43 - 588{,}09x$	$1239{,}63 - 90{,}13x$
P	$398{,}96 - 65{,}5x$	$346{,}86 - 24{,}21x$
Ca	$3327{,}55 - 26{,}2x$	$314{,}16 + 0{,}32x$
Na	$1449{,}07 - 41{,}03x$	$216{,}58 + 39{,}49x$
K	—	$2310{,}6 - 131{,}64x$
Mg	$-1676{,}87 + 135{,}64x$	$395{,}91 - 10{,}02x$
Mn	$13{,}16 + 193{,}37x$	$6{,}13 + 92{,}18x$
Zn	$1{,}75 + 34{,}12x$	$1{,}12 + 1{,}77x$
Fe	—	$113{,}22 - 4378{,}92x$
Cu	$0{,}46 + 9{,}01x$	$0{,}17 + 5{,}54x$
	Stengel	Blatt
N	$968{,}5 + 82{,}56x$	$2597{,}42 - 25{,}11x$
P	$616{,}66 - 9{,}73x$	$733{,}50 - 43{,}00x$
Ca	$1944{,}73 - 14{,}66x$	$3217{,}33 - 26{,}02x$
Na	$349{,}04 + 99{,}44x$	$111{,}43 + 14{,}8x$
K	$535{,}42 + 552{,}98x$	$3550{,}59 - 379{,}27x$
Mg	$188{,}89 + 11{,}89x$	$121{,}06 + 16{,}81x$
Mn	$8{,}48 + 588{,}31x$	$8{,}68 + 550{,}33x$
Zn	$+2{,}61 - 169{,}99x$	$1{,}2 + 29{,}52x$
Fe	$54{,}13 - 1780{,}99x$	$63{,}16 - 2166{,}17x$
Cu	$0{,}16 + 7{,}96x$	$0{,}34 + 7{,}4x$

Es ist gut zu beobachten, daß die Mn- und Mg-Konzentration in den Wurzeln stark ansteigt, wenn sich auch die Konzentration im Wasser erhöht (Abb. 1). Steigt der N-Gehalt des Standortes, verringert sich die in den Wurzeln gemessene Konzentration stark. Das Rhizom (Abb. 2), als Speicherorgan, zeigt ein im wesentlichen ausgeglichenes Bild, die Schwankungen der Verände-

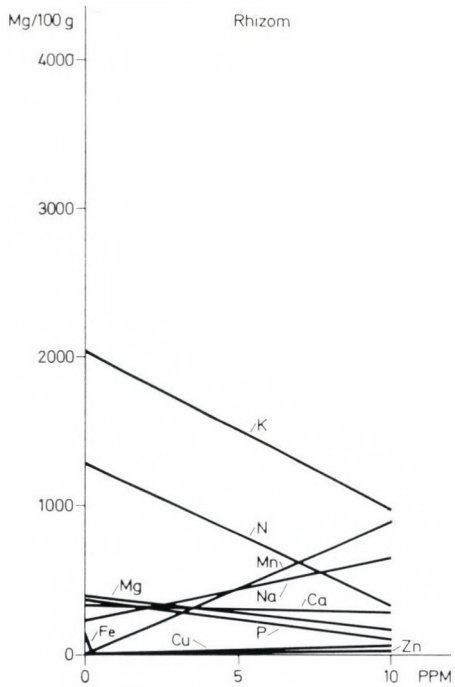

Abb. 2.

rungen sind gering. Im Stengel (Abb. 3) beobachten wir mit steigender Nährstoffkonzentration die größte Akkumulationsbereitschaft gegenüber K und Mn. Wenn sich im Standort die N- und P-Konzentration erhöht, sinkt die Akkumulationsbereitschaft etwas, jedoch nur in sehr geringem Maße. In den Blättern (Abb. 4) finden wir in Bezug auf Mn ähnliche Verhältnisse wie im Stengel, K reagiert jedoch genau gegenteilig, es zeigt eine stark sinkende Tendenz.

Der Korrelationswert (r) drückt den Zusammenhang zwischen der Konzentration der Biogenelemente (ppm) im Standort (Wasser) und der Konzentration der Biogenelemente (mg/100 g) in den Pflanzen aus (Tabelle 1).

Im Falle des Phosphors ist die Korrelation in allen Organen gleichmäßig schwach ausgeprägt.

Der N-, Fe-, Mn-Gehalt in den Rhizomen zeigt einen engen Zusammenhang mit dem Gehalt ähnlicher Biogenelemente im Wasser. Der Zusammenhang des N-, Mn-, Ca-Gehaltes in den Wurzeln zeigt ebenfalls eine enge Korrelation zu dem Gehalt im Wasser, außerdem besteht auch ein ausreichender Zusammenhang bei Zn, Cu und Na. Im Stengel konnten wir bei den meisten der 10 überprüften Elemente eine enge Korrelation zwischen Standort und Pflanzen feststellen: Ca, K, Fe, Mn, Zn und Cu. Der Zusammenhang zwischen der

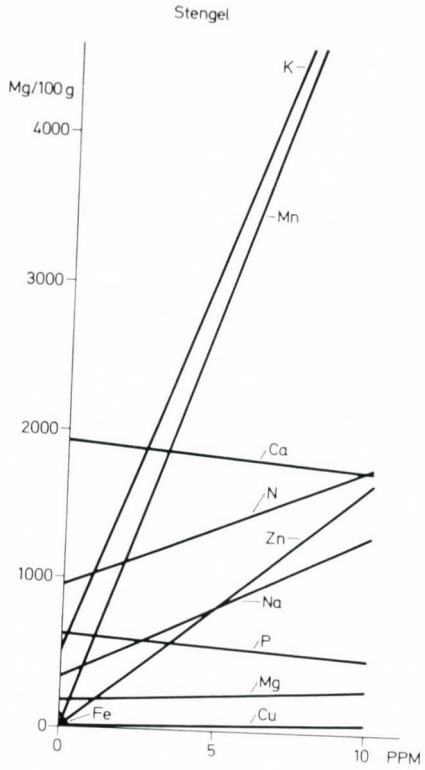

Abb. 3.

Tabelle 1

Korrelationswerte für den Gehalt an Biogenelementen in den Organen der Nuphar lutea und der Konzentration der Biogenelemente im Wasser

	Wurzel	Rhizom	Stengel	Blatt
N	0,996	0,899	0,696	0,241
P	0,292	0,178	0,046	0,169
Ca	0,937	0,202	0,987	0,994
Na	0,778	0,573	0,671	0,284
K	—	0,149	0,969	0,384
Mg	0,613	0,418	0,248	0,408
Mn	0,941	0,995	0,992	0,997
Zn	0,807	0,417	0,910	0,853
Fe	—	0,989	0,988	0,976
Cu	0,802	0,841	0,919	0,780

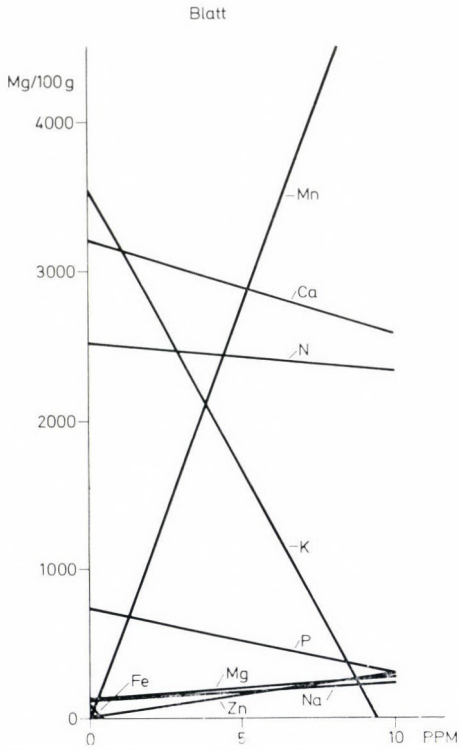

Abb. 4.

Konzentration der Biogenelemente in den Blättern und im Wasser zeigt für Ca, Mn und Fe eine enge Beziehung.

Die verhältnismäßig enge Korrelation der Mikroelemente (Mn, Zn, Fe, Cu) in den von uns untersuchten Organen und im Wasser ist bezeichnend.

Die Gestaltung der Absolutwerte der einzelnen sich in den Pflanzen befindlichen Biogenelemente, in Abhängigkeit davon, im welchem Maße die anderen sich in den Pflanzen befindlichen Biogenelemente durch ihr Relativgewicht (%-wert) dieselbe fördern oder behindern, zeigt Tabelle 3.

Die N-Akkumulation wird von den Makrobiogenen P (0,23) und K (3,7) in geringem Maße negativ beeinflußt. Von den Mikroelementen beeinflussen sie in steigendem Maße Cu und Fe negativ. Den größten positiven Wert bei der durch lineare Regressionsrechnung ermittelten Gewichtsverhältnisveränderung zeigte das Ca (62,14%).

Auf die P-Akkumulation wirkten sich mit steigender Tendenz in geringem Maße negativ folgende Elemente aus: N (0,8), Mg (—6,87) und Zn (—12,36). Im positiven Sinne beeinflußt sie Fe (54,8%) und Ca (37,6%) am meisten.

Tabelle 2

Die Relativgewichts-Prozente der Biogenelemente in den Pflanzen (Nuphar lutea)

	N	P	Ca	Na	K	Mg	Mn	Zn	Fe	Cu
N	—	−0,80	1,97	3,43	−0,40	0,16	0,21	1,26	−0,24	−0,19
P	−0,22	—	3,48	2,17	0,81	−1,74	1,40	−2,86	7,40	0,20
Ca	62,14	37,60	—	9,83	30,70	0,39	51,31	−8,99	26,54	4,05
Na	21,96	4,72	1,99	—	3,28	0,16	6,72	22,31	−2,91	0,82
K	−3,17	2,18	7,65	4,03	—	28,08	1,64	7,93	1,81	−1,57
Mg	1,80	−6,87	0,14	0,29	41,40	—	−1,97	1,39	37,19	9,41
Mn	9,02	20,07	68,69	44,34	8,80	−7,17	—	77,70	8,40	47,06
Zn	15,99	−12,36	−3,53	44,20	12,80	1,52	23,34	—	0,27	0,66
Fe	−5,25	54,18	18,10	−9,79	4,95	69,07	4,28	0,46	—	39,57
Cu	−2,27	0,79	1,50	1,50	−2,34	9,53	13,07	0,61	21,56	—

Das Gewichtsverhältnis der Ca-Akkumulation wird durch die übrigen Biogenelemente nicht so wirksam verändert. In geringem Maße wird es durch Zn (—3,53%) gesenkt, durch Mn (68,69%) jedoch steigt die Akkumulation stark an.

Das Na-Akkumulationsverhältnis wird auch mehr durch die Mikroelemente bestimmt. Fe (—9,79%) wirkt sich negativ aus, Mn (44,34%) und Zn (44,2%) zeigen hingegen eine positive Wirkung.

Die K-Menge verändert sich durch N (—0,4%) und Cu (—2,34) nur wenig in negativer Richtung. In erster Linie jedoch zeigt sie eine positive Korrelation mit Ca (30,7%) und Mg (41,4%).

Die Mg-Akkumulation wird geringfügig von P (—1,74%) und Mn (—7,17%) in negativer Richtung beeinflußt, Fe (69,07%) wirkt sich günstig aus.

Die Mn-Akkumulation wird durch Mg (—1,97) ein wenig gestört, den günstigsten Einfluß hat das Ca (51,31%), aber auch Zn (23,34%) wirkt sich fördernd aus.

Die Zn-Akkumulation wird durch Ca (—8,79%) am meisten gestört, auch P (—2,86%) wirkt negativ. Mit Mn (77,7%) und Na (22,3%) besteht ein positiver Zusammenhang. Auch die Fe-Akkumulation wirkt sich in sehr geringem Maße N (—0,24%) negativ aus, ähnliches gilt für Na (—2,9%), die positive Richtung wird in beinahe übereinstimmendem Maße von Ca (26,54%) und Zn (21,56%), und noch stärker von Mg (37,19%) bestimmt, bzw. gefördert.

Die Cu-Akkumulation wird durch N (—0,19%) und K (—1,57%) nur sehr geringfügig negativ beeinflußt, die übrigen Elemente zeigen keine Wir-

kung, außer Mn (47,06%) und Fe (39,57%), die die Akkumulation stark fördern.

Das vorgetragene Material ist natürlich nur ein kleiner Auszug, womit wir unsere Bedingungen am Kisbalaton aufzeigen wollten.

Mit denselben Methoden wurden außer *Nuphar lutea* auch *Trapa natans, Ceratophyllum demersum* und *Stratiotes aloides* ausgewertet. Bei den vorher erwähnten Pflanzenarten ist besonders die schnelle Zunahme ihrer Primärproduktion auffallend, die auf der Nährstoffanreicherung des Standortes beruht. Sie dienen als Indikatorarten für eine starke und rasche Eutrophisierung.

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UNTERSUCHUNG DES NÄHRSTOFFTRANSPORTS IM BODEN DES EICHEN-ZERREICHENWALDES*

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Within the scope of the research of the bioelement cycle of a turkey oak-sessile oak forest ecosystem the quantity of elements reaching the soil surface and leaving it has been determined.

In the chemical composition of the so-called litter lysimeter, there can be seen a seasonality, which depends on the degree of litter decomposition, the phenological conditions of the forest (degree of foliation), further on the chemical composition and the possible caterpillar gradation.

On the basis of the chemical composition of the gravitational water the migration of biogenic elements in the soil can be determined. On the strength of the input and output data the nutrient balance of the soil can be estimated.

Einleitung

Eine der grundlegenden Zielsetzungen des MAB-Programms besteht in der Untersuchung der Verteilung und Zirkulation der wichtigsten Bioelemente in den repräsentativen Ökosystemen der verschiedenen Biomen. Es ist nötig, daß das vom Gesichtspunkt der biologischen Produktion im Ökosystem bestehende Bilanz-Gleichgewicht der wichtigsten Elemente bestimmt werden soll. Kalium, Schwefel und die Spurenelemente müssen besonders beachtet werden.

Den obigen Grundprinzipien entsprechend wurde in Ungarn als repräsentatives Ökosystem ein Eichen-Zerreichenwald (*Quercetum petraeae-cerris*) festgesetzt, der eine zonale Assoziation des Ungarischen Nordöstlichen Mittelgebirges ist.

Die Probefläche befindet sich in der südlichen Hügellandschaft des Bükk-Gebirges, in einer Meereshöhe von 270—300 m (eingehende Beschreibung der Probefläche s. bei Jakucs, 1973).

Der Boden des Verjüngungswaldbestandes ist die Parabraunerde (Beschreibung des Bodenprofils s. bei Kovács, 1978). Das Ziel unserer hier veröffentlichten Untersuchungen bestand in der quantitativen Bestimmung der in den Boden gelangenden und von dort ausscheidenden Bioelemente.

Die Untersuchung der im Rahmen des Bioelementumsatzes in den Boden gekommenen und von dort austretenden Elemente setzt sich aus folgenden Teilergebnissen zusammen:

— Menge der durch das Laub fallenden und mit dem am Stamm abfließenden Niederschlag an die Bodenoberfläche gelangenden Elemente (Szabó and Csortos, 1975 und ined. Material)

— Menge der aus der Waldstreu an der Bodenoberfläche frei gewordenen Bioelemente

* "Síkfőkút-Project": No. 55.

— Gehalt des Bodens an organischen Stoffen und Elementen und seine saisonale Änderung
— Menge und Konzentration des im Boden strömenden Gravitationswassers und Summe der aus dem Bodenhorizont von 100 cm ausscheidenden Elemente, die vermutlich in das Grundwasser gelangen.

Die Wälder spielen eine bedeutende Rolle in der Wasserwirtschaft eines gegebenen Gebiets und die Untersuchung ihrer Wasserwirtschaftsverhältnisse ist eine besonders wichtige Aufgabe.

In den kommenden Jahrzehnten muß man — infolge des zunehmenden Wasserverbrauches — mit einer negativen Wasserbilanz rechnen, ebendeshalb wird in ganz Europa die Rolle der Wälder in der Neubildung des Grundwassers untersucht.

Infolge der wachsenden Luftverunreinigung gelangen — zusammen mit dem Niederschlag — immer mehr Stickstoff, Schwefel und verschiedene Schwermetalle, usw. an die Bodenoberfläche, welche von dem Waldökosystem geläutert werden, und auf diese Weise spielt das Waldökosystem in der Neubildung von Grundwasser eine spezielle Rolle.

Untersuchungsmethoden

Zur Bestimmung der Menge der aus der Waldstreu frei werdenden Elemente wurden in die Rasenschicht des Waldes mit kunststofflichem Siebgewebe versehene und auf Kunststoffeimer gesetzte sog. Auffanggefäße aufgestellt. Im Auffanggefäß haben sich die abgefallenen Blätter der Laubkronen- und Strauchschicht (Waldstreu) angesammelt. Die Menge der in den Eimern angehäuften Lösung hängt von der Menge des Niederschlags, bzw. von der Summe des durch die Laubkronen- und Strauchschicht fallenden Niederschlags ab. Die chemische Zusammensetzung der Lösung hängt von folgendem ab:
— Elementgehalt des durch die Laubkronen- und Strauchschicht fallenden Niederschlags
— Menge der Elemente, die im Laufe des Abbaus der im Auffanggefäß befindlichen Waldstreu frei geworden sind und die infolge des Niederschlagswassers ausgewaschen werden.

Die Quantität der mit Hilfe des Wassers strömenden, bzw. wandernden und der aus dem Ökosystem austretenden Elemente wurde mittels Säulenlysimeter untersucht, die in dreifacher Wiederholung in der Tiefe von 10, 30, 50 und 100 cm angesetzt wurden.

Es wurden folgende Elemente untersucht: Ca, K, Na, Mg, N (NH_4, NO_3), P (PO_4), S (SO_4), Mn, Cl. In dem Waldstreulysimeter haben wir auch die Menge von Fe und Zn gemessen.

Boden-input

Die Lösungskonzentration des Streulysimeters ändert sich je nach der chemischen Zusammensetzung des durch die Laubkronenschicht fallenden Niederschlags und der Menge der durch die Streumineralisation frei gewordenen Elemente. Die Zunahme der Konzentration der Lösung erfolgt im Frühling (Vorsommer) und im Herbst (Winter) (Abb. 1).

Die Ursache der Zunahme der Lösungskonzentration im Frühling-Frühsommer liegt darin, daß sich die Quantität der Elemente in dem durch die Laubkronenschicht fallenden Niederschlag bedeutend anreichert (Szabó und Csortos, 1975) ferner darin, daß zufolge der günstigen Temperatur- und Feuchtigkeitsverhältnisse der Abbau der im Herbst gefallenen Blätter (Wald-

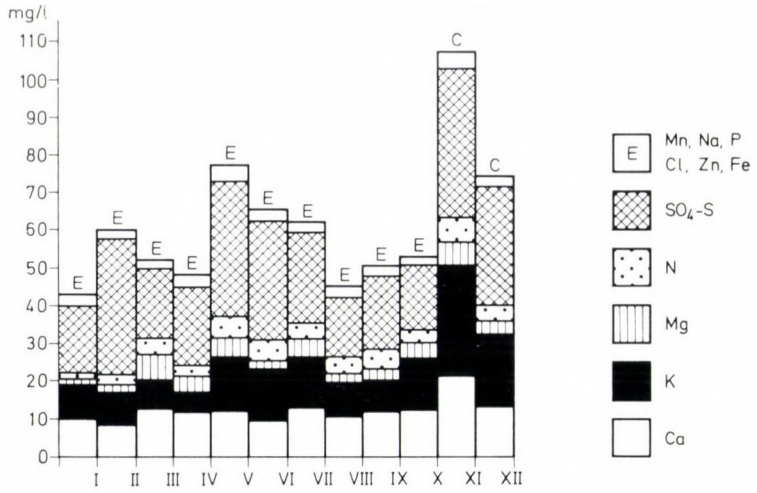

Abb. 1. Elementkonzentration der Lösung des Streulysimeters

streu) schneller wird. Von allem wird die Quantität des Schwefels und des Kaliums größer. Ein Teil des Kaliums gelangt mit dem durch das Laub fallenden Niederschlag und infolge der Auswaschung aus den lebenden Blättern (FISCHER, 1972) an die Bodenoberfläche.

Ein anderer Teil des Kaliums stammt aus der Mineralisation der Waldstreu. Das Kalium wird im Laufe des Abbaus sehr schnell frei, wie das auch von den Laboruntersuchungen bewiesen wurde (KOVÁCS, 1977).

Bei der saisonalen Änderung der im Streulysimeter meßbaren Lösungskonzentration spielt auch die in den Frühlingsmonaten der einzelnen Jahre auftretende Raupengradation eine Rolle. Demzufolge nimmt der SO_4-S, NH_4-N, NO_3-N und PO_4-P-Gehalt der Lösung zu (vgl. Abb. 1).

Aufgrund der Daten von VARGA (ined.) reichern sich — mit Bezug auf den Elementgehalt der *Quercus petraeae*-Blätter (Raupennahrung) — die verschiedenen Elemente in der Raupe und in ihrer Fäzes in folgender Menge an*:

	Raupe	Fäzes
Stickstoff	3,9	2,7
Phosphor	2,5	2,3
Natrium	1,4	1,8
Kalium	1,4	0,8

* Anreicherungsfaktor:

$$\frac{\text{Gehalt an Elementen der Raupe und der Fäzes}}{\text{Gehalt an Elementen der Quercus petraea-Blätter}}$$

Die infolge der Raupengradation auftretende Anreicherung an Elementen ist sowie in den Humus- (0—10 cm), wie auch in den Bodenlysimetern nachzuweisen.

Das zweite Konzentrationsmaximum der Lösung ist im Streulysimeter in der Herbst-Winterperiode, (vielleicht im Vorfrühling), zur Zeit des bedeutenden Laubblattfalles zu messen. Im Laufe der Mineralisation nimmt vor allem die Menge von Kalium, Kalzium, Stickstoff und Schwefel zu.

Mit dem in den Wald gelangenden Niederschlag und infolge der Mineralisation der Waldstreu fällt von den verschiedenen Bioelementen — aufgrund der Daten von vier Jahren (1975—1978) — auf eine Bodenoberfläche von 1 ha folgende Menge (kg):

Ca	55,6
K	57,0
Na	3,1
Mg	18,8
N**	22,4
P***	4,0
S****	113,5
Cl	14,2
M_n	5,8
Z_n	1,6
Fe	1,0

$N^{**} = NH_4 \cdot N + NO_3 \cdot N$
$P^{***} = PO_4 - P$
$S^{****} = SO_4 - S$

Menge des Gravitationswassers im Boden

Aufgrund der Meßdaten von vier Jahren gelangt der Niederschlag in die einzelnen Bodenhorizonte in folgendem Prozentverhältnis:

10 cm	45—60%
30 cm	38—46%
50 cm	17—36%
100 cm	13—21%

In den Jahren 1975—1978 erhielt — den Niederschlagsverhältnissen entsprechend (575—807 mm) — der 100 cm tiefe Bodenhorizont 92—140 l Wasser/m². Der Eichen-Zerreichenwald erneut das Grundwasser mit einer solchen Menge von Gravitationswasser.

Zwischen dem gefallenen Niederschlag und der Menge des Gravitationswassers kann folgender mathematischer Zusammenhang festgestellt werden:* (y = ml, x = mm, auf einen Säulenlysimeter mit einer Fläche von 50×50 cm gerechnet).

* Die Korrelationsrechnungen wurden von J. PODANI verfertigt.

in 10 cm tiefem Bodenhorizont $y = 2716{,}2 + 97{,}8 \cdot x$ $r = 0{,}790^{0.1\%}$
in 30 cm tiefem Bodenhorizont $y = 763{,}3 + 96{,}7 \cdot x$ $r = 0{,}851^{0.1\%}$
in 50 cm tiefem Bodenhorizont $y = 176{,}2 + 59{,}4 \cdot x$ $r = 0{,}755^{0.1\%}$
in 100 cm tiefem Bodenhorizont $y = 361{,}4 + 60{,}5 \cdot x$ $r = 0{,}850^{0.1\%}$

Die Richtungstangente (b-Wert) der Regressionsgerade ist gegen die 50 und 100 cm tiefen Horizonte »flacher« (schließt einen kleineren Winkel ab), was mit der größeren Tonfraktion der unteren Bodenhorizonte zusammenhängt.

Elementkonzentration des Gravitationswassers

Die Elementkonzentration des Gravitationswassers hängt von folgenden Faktoren ab:

— Gehalt an Elementen des durch die Laubkronenschicht fallenden, am Baumstamm abfließenden Niederschlags
— Gehalt an Elementen des durch die Streuschicht sickernden Wassers
— chemische Zusammensetzung des Bodens.

Die Elementkonzentration des Gravitationswassers ist in den einzelnen Horizonten verschieden (Tabelle 1), was mit der chemischen Zusammensetzung

Tabelle 1

Elementkonzentration des Gravitationswassers in mg/l

cm	Ca	K	Na	Mg	N+	P++	S+++	Mn	Cl
10	7,0	3,1	1,1	7,7	10,7	0,10	5,7	0,10	4,3
30	7,1	0,9	1,9	7,7	13,8	0,05	5,7	0,05	3,6
50	17,5	0,9	4,1	16,6	25,8	0,05	11,9	0,04	5,1
100	32,3	0,8	9,7	19,4	20,9	0,04	11,4	0,75	4,8

$N^+ = NH_4-N + NO_3-N$
$P^{++} = PO_4-P$
$S^{+++} = SO_4-S$

der verschiedenen Bodenhorizonte und mit der Mobilität der einzelnen Elemente zusammenhängt. Laut der Bodenuntersuchungsdaten (Kovács, 1978) nimmt in 30 cm Tiefe die Menge von adsorbiertem Ca, Mg und Na zu. Dementsprechend, sowie zufolge der bedeutenden Mobilität von Ca, Mg und Na nimmt der Ca-, Mg- und Na-Gehalt des Gravitationswassers angefangen von dem 50 cm tiefen Horizont zu. In den tieferen Bodenhorizonten wird die Konzentration von NO_3, SO_4 und Mn ebenfalls größer. Phosphor und Kalium kommen in verhältnismäßig größerer Menge nur im oberen Bodenhorizont vor.

Der Anreicherungsfaktor der Elemente* ist im Gravitationswasser des 100 cm tiefen Horizontes wie folgt:

Na	8,8
Mn	7,5
Ca	4,6
Mg	2,5
S (SO_4—S)	2,0
N (NO_3—N)	1,9
Cl	1,1
P (PO_4—P)	0,4
K	0,2

Boden-output, Migration der Elemente im Boden

Aufgrund der Untersuchungsdaten von vier Jahren treten aus dem 100 cm tiefen Bodenhorizont etwa 77 kg Bioelemente aus (Tabelle 2).

Annähernd die Hälfte der Kalziummenge gelangt mit dem durch die Laubkronenschicht fallenden Niederschlag, die andere Hälfte dagegen infolge des Waldstreuabbaus an die Bodenoberfläche (bei dem Elementgehalt des Niederschlags wurden die Daten von SZABÓ und CSORTOS, 1975 und ined. berücksichtigt). Im Laufe der Mineralisation der Waldstreu wird das Kalzium um etwas langsamer frei als das Kalium. Etwa 50% des in den Boden gelangten Kalziums wird durch die Fraktion organischen Materials und die Tonfraktion gebunden, diese Menge ist für die Pflanzen zugänglich. In den tieferen Bodenhorizonten nimmt der Ca-Gehalt des Gravitationswassers zu und etwa 26 kg scheidet aus dem Ökosystem aus.

Der größte Teil des Kaliums gelangt infolge des Streuabbaus, sowie mit dem durch die Laubkronenschicht fallenden Niederschlag an die Bodenoberfläche, wo es vom organischen und Tongehalt des Bodens adsorbiert wird. Es ist ein sich stark bindendes Element, das bereits in der aufgefangenen Lösung des 30 cm Lysimeters nur in kleinen Mengen vorkommt. Aus dem Ökosystem tritt je Hektar durchschnittlich eine Menge von 3 kg aus.

Im Laufe des Abbaus der Waldstreu kommt etwa 1—3 kg Na an die Bodenoberfläche und ung. das Zwei-Dreifache dieser Menge kann im Gravitationswasser des 100 cm tiefen Horizonten gemessen werden. Der Na-Gehalt des Gravitationswassers nimmt — im Zusammenhang mit dem adsorbierten Na-Gehalt des Bodens — in den unteren Bodenhorizonten zu.

Der Großteil des Magnesiums kommt auf dem Wege der Mineralisation der Waldstreu in den Boden. Es wird in dem Humushorizont nur in kleinen Mengen adsorbiert, seine Konzentration wächst dagegen in den tieferen Horizonten des Bodens.

$$* \text{ Anreicherungsfaktor} = \frac{\text{Konzentration des Elements in 100 cm Tiefe, mg/l}}{\text{Konzentration des Elements in 10 cm Tiefe, mg/l}}$$

Mit der zunehmenden Luftverunreinigung kommt in das Ökosystem immer mehr Stickstoff. In der Parabraunerde tritt der größte Teil des Stickstoffes in organischer Bindung auf.

Der von den Pflanzen aufnehmbare Stickstoff kommt in der Form von Ammoniak vor (14—26 kg NH_4-N/ha im 0—20 cm tiefen Bodenhorizont). Das Ammoniak wird im oberen Bodenhorizont gebunden und als Kation adsorbiert.

Der Stickstoff verläßt das Ökosystem vor allem in der Form von Nitrat, im Durchschnitt 20 kg/ha. In der Änderung des gesamten Stickstoff-, Ammoniak- und Nitratgehaltes des Bodens kann außer dem Herbststreuabbau auch der infolge der Raupengradation an die Bodenoberfläche gelangte Stickstoff nachgewiesen werden.

Mit der Gestaltung des Bodenstickstoffgehaltes, sowie mit den im Lysimeter meßbaren NH_4-N und NO_3-N-Werten steht auch die Nitrifikationsdynamik der Parabraunerde im Zusammenhang.

Laut unserer Untersuchungen auf dem Gelände und im Laboratorium (Kovács, 1978) ist die Intensität der Mineralisationsdynamik in den Monaten April—Mai—Juni (in diesem letzteren wurde das Maximum gemessen), sowie parallel zum Herbstlaubfall, in den Monaten September—Oktober und November am stärksten. (Die Nitrifikationsdynamik wird auch von der Temperatur und der Bodenfeuchtigkeit beeinflußt.)

Aus Phosphor gelangt jährlich 4 kg an die Bodenoberfläche, wo der größte Teil dieser Menge adsorbiert wird und die Summe kann fast vernachlässigt werden (0,06 kg/ha), die aus dem Ökosystem austritt.

Ein Teil der Schwefelmenge (SO_4-S) kommt mit dem Niederschlag, ein größerer Teil derselben mit der Waldstreu (bzw. infolge der Konsumption der Laubblätter durch die Raupen) an die Bodenoberfläche. Etwa 90—95% dieser Schwefelmenge wird in dem organischen Material des Bodens und in seinem Tongehalt angehalten.

Ein bedeutender Teil des Chlorids kommt mit dem Niederschlag in das Ökosystem, aus der Waldstreu wird nur eine kleine Menge frei. Etwa 85—90% der Chloridmenge erreicht nicht die tieferen Bodenhorizonte und es tritt jährlich annähernd 2 kg Cl von dem 1 m tiefen Bodenhorizont des Waldbodens pro Hektar aus.

Der größte Teil des Mangans gelangt aus der Waldstreu in den Boden und mit dem Gravitationswasser verläßt nur eine kleine Menge denselben (0,3 kg/ha).

Nährstoffbilanz der Parabraunerde

Mit dem Niederschlag (input) gelangen folgende Elemente in größerer Quantität in das Ökosystem: N, SO_4-S, Ca und Cl.

In dem durch die Laubkronenschicht fallenden Niederschlag reichern sich folgende Elemente an: SO_4-S, K, Ca, N und Cl. Die Wirkung der Laub-

kronenschicht zeigt sich vor allem in der K-Anreicherung an (vgl. SZABÓ und CSORTOS, 1975).

Infolge des Streuabbaus kommen mit dem durch die Waldstreu sickernden Niederschlag (Boden-input) folgende Elemente in größerer Quantität in die Bodenlösung: SO_4-S, K, Ca, N, Mg und Cl (vgl. Tabelle 2). Ein bedeutender Teil dieser Elemente wird von der Humus- und Tonfraktion des oberen Bodenhorizontes adsorbiert.

Tabelle 2

Bilanz der Bioelemente im Boden (kg/ha)
(Aufgrund der Daten aus den Jahren 1975—1978)

	Ca	K	Na	Mg	N+	P++	S+++	Mn	Cl
A	14,7	4,2	1,4	1,8	24,1*	1,1	18,6	0,3	13,4
B	55,6	57,0	3,1	18,8	22,4	4,0	113,5	5,8	14,2
C	28,7	0,3	6,4	13,4	20,2	0,06	6,2	0,3	1,9
D = B — C	+26,9	+56,7	—3,3	+5,4	+2,2	+3,94	+107,3	+5,5	+12,3

A = Menge der mit dem Niederschlag in den Boden gelangenden Elemente (II—XII, 1974—1975) (SZABÓ—CSORTOS 1975 und ined.)
B = Menge der an die Bodenoberfläche gelangenden Elemente (Boden-input)
C = Menge der aus dem 100 cm tiefen Bodenhorizont austretenden Elemente (output)
D = Bilanz in Hinsicht auf den Boden

* 80—90 Prozent des Niederschlags ist organischer Stickstoff!
$N^+ = NH_4—N + NO_3—N$
$P^{++} = PO_4—P$
$S^{+++} = SO_4—S$

Tabelle 3

Quantitätsreihenfolge der in dem — durch das Eichen-Zerreichenwaldökosystem fließenden — Wasser befindlichen Bioelemente

1. N > S > Ca > Cl > K > Na > Mg > P > Mn > Zn > Fe
2. S > Ca > N > K > Cl > Mg > P > Mn > Na > Zn > Fe
3. S > Ca > K > Mg > N > Cl > Mn > Na > Zn > P > Fe
4. N > Mg > Ca > S > Cl > K > Na > Mn > P
5. N > Mg > Ca > S > Cl > Na > K > Mn > P
6. N > Mg > Ca > S > Na > Cl > K > Mn > P
7. Ca > N > Mg > S > Na > Cl > Mn > K > P

1. Niederschlag (SZABÓ—CSORTOS ined.)
2. Durch das Laub fallender Niederschlag (SZABÓ—CSORTOS ined.)
3. Durch die Waldstreu sickerndes Wasser
4. Gravitationswasser in der Bodentiefe von 10 cm
   ,, ,, ,, ,, ,, 30 cm
   ,, ,, ,, ,, ,, 50 cm
   ,, ,, ,, ,, ,, 100 cm

Die mit dem Gravitationswasser in den 100 cm tiefen Bodenhorizont und von hier vermutlich in das Grundwasser in größeren Quantitäten gelangenden Elemente sind folgende: Ca, N, Mg.

In den verschiedenen Schichten des Waldökosystems ändert sich die Reihenfolge der einzelnen Elemente aufgrund der Quantitätsverhältnisse (Tabelle 3). Aufgrund der Boden input-output-Daten (vgl. Tabelle 2) ist in den untersuchten Elementen — ausgenommen Na — die Bilanz für den Boden positiv, bzw. folgende Elemente zeigen einen Gewinn für den Boden: Ca, K, Mg, N, P, S, Mn, Cl.

Zusammenfassung

Die Bilanz der Parabraunerde des Eichen-Zerreichenökosystems ist — ausgenommen Na — positiv. Die Elemente werden im Boden in folgender Reihenfolge angehalten: S > K > Ca > Cl > Mn > Mg > P > N.

Die natürlichen Ökosysteme spielen — infolge der Filterwirkung ihres Bodens — eine bedeutende Rolle in der Grundwassererneuerung. Von den Niederschlagsverhältnissen abhängend gelangt in 1 m^2 des 100 cm tiefen Bodenhorizontes 82—140 l Wasser.

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THE CONDITIONS OF PHYTOMASS PRODUCTION AND ENERGY UTILIZATION IN *FESTUCO VAGINATAE-CORYNEPHORETUM* MEADOWS OF ACIDIC SANDY SOIL IN THE INTERNAL PART OF THE COUNTY OF SOMOGY (SW HUNGARY), I.

By

Edit Kovács-Láng

DEPARTMENT OF PLANT TAXONOMY AND ECOLOGY L. EÖTVÖS UNIVERSITY, BUDAPEST

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The studies on phytomass production which had earlier been carried out on calciferous sandy meadows in the Danube—Tisza midregion at Csévharaszt — were extended to acidic sandy meadows in Transdanubia.

In 1977, from March to October, the aboveground and underground phytomass of 11 pieces of 20 × 20 × 20 cm soil monolith as well as the changes in the organic matter of the soil were examined monthly in *Festuco vaginatae-Corynephoretum* meadows.

Compared with sandy meadows of the Danube—Tisza region, the quantity and ratio of phytomass fractions showed differences according to the climatic conditions.

In Inner-Somogy, which is of a humidic climate, the aboveground phytomass is bigger, while that of the underground parts is smaller, the value of the root importance index is lower than that of the semiarid sandy meadows of the Danube—Tisza region.

NET primary production and the efficiency of the aboveground standing parts also proved to be higher than those in the sandy meadows of the Danube—Tisza region.

Introduction

The beginning of the investigations on phytomass production in Hungary can be traced as far back as the period of plant cenology and meadow typology, but a systematic study which adapted the methods of international standards started only within the framework of IBP investigations.

The methodological basis of the studies was prepared in the HAS Research Institute for Botany of Vácrátót, and the investigations on the vegetation types appointed in the country — loess forest steppe at Újszentmargita and sandy forest steppe at Csévharaszt — were launched. The results obtained so far have been published in a number of articles (Máthé—Précsényi—Zólyomi, 1967; Zólyomi—Máthé—Précsényi—Szőcs, 1972, 1974; Zólyomi—Précsényi, 1970; Précsényi, 1967, 1969, 1970, 1971, 1973).

Our Department has studied the phytomass production and the environmental factors influencing it in calcareous sandy meadows in the area of sandy forest steppe of the Danube—Tisza region for several years (Kovács-Láng—Szabó, 1971, 1973; Simon—Kovács-Láng, 1972; Verseghy—Kovács-Láng, 1971; Kovács-Láng, 1974, 1975).

The examinations begun at Csévharaszt in the past years were extended to other sandy areas of the country as well.

Here the results of the production examinations carried out in the perennial open sandy meadow (*Festuco vaginatae-Corynephoretum*) Inner-Somogy (South-West Hungary) will be presented.

For the purpose of our examinations sample area was appointed in the surrounding of Böhönye and Nagybajom.

Site characteristics

The Böhönye and Nagybajom region can be categorized of the extensive Inner-Somogy shifting sand surface. The sand cover exceeding occasionally a thickness of 100 m is a fluvial deposit of the Pleistocene period whose present-day surface was formed by the wind during the late Pleistocene. The Nagybajom region is known for its sand movement of the Holocene period. The relief is very vivid and varying, with wind furrows, and sand-hills and heaps of sand, forming 6—10 m differences in height within very short distances. This surface is not suitable for agricultural cultivation, thus the original vegetation has remained on it.

The climate of this area can be established on the basis of the climatic diagram designed from data obtained from the meteorological station of Kaposvár (data on 40 years) (Fig. 1).

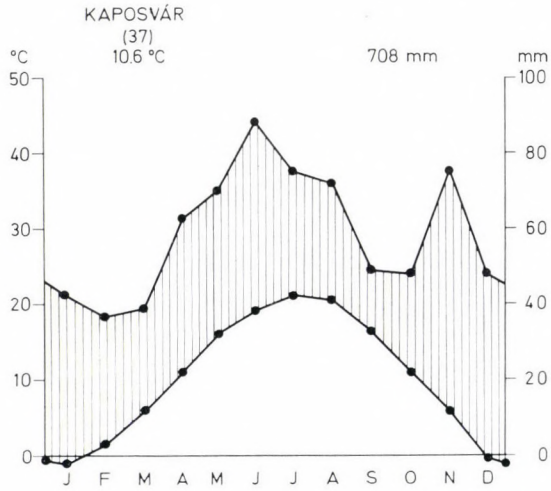

Fig. 1. The climatic diagram of Kaposvár

The mean annual temperature is 10.6 °C. This is slightly higher than that of the Danube—Tisza region or the sandy areas of the Nyírség, which is a consequence of the milder winter months. The amount of annual sunshine is 1800 hours, which is lower than the 2000-hour value of the regions mentioned above.

The amount of the annual precipitation is 700—720 mm. Its distribution shows an early-summer and late-autumn maximum. The latter makes the climate of a definitely sub-mediterranean character (Borhidi, 1958). Analysing the data of the Somogyszob measuring centre, Jakucs, Marosi and Szilárd found that 68% of the given years was of sub-mediterranean character. On the basis of the distribution of precipitation, the climate diagram of Kaposvár indicates a humid climate throughout the year, but temporarily mainly in summer dry periods also occur (Borhidi and Komlódi, 1959).

The data on precipitation obtained from the meteorological station of Nagybajom provide an accurate picture on the local weather conditions in the year under study. In 1977 the amount of the annual precipitation was 731 mm. In April and May, as well as in August and October it was much lower than the average, while in June and November much higher.

The monthly amount of precipitation (mm)
(Nagybajom, 1977)

J	F	M	A	M	J	J	A	S	O	N	D
61.3	46.6	48.1	50.8	18.6	145.2	68.4	46.0	50.6	25.2	127.6	41.2

According to the climatic conditions, the natural vegetation of Inner-Somogy consists of deciduous forest. On the dry hill tops, lying far from groundwater table turkey-oak forests (*Quercus cerris*) with *Asphodelus*, while in the lower, flat, wetter areas with *Pteridium* can be found (Borhidi, 1958).

On tops and sides of the most exposed sand hills of the surfaces having a very vivid relief a mosaic of sparse forests and sandy meadows can be found to a limited extend.

Concerning our investigations on the phytomass production the perennial open sandy meadow of an exposed sand hill top lying some 100 m from the road between Nagybajom and Böhönye was chosen.

This habitat is characterised by microclimatic extremities (Jakucs, Marosi and Szilárd, 1967). According to their measurements carried out in August, a great daily amplitude of temperature can be observed with respect to the sand hill top as well as a sudden warming up and cooling down furthermore, a lower rate of air vapour content than that of in the neighbourhood, and stronger air movement.

The vegetation is open, consisting of about 60—70% cover of the meadow. The dominant meadow-forming plant in it is *Festuca vaginata*, beside *Corynephorus canescens*, *Koeleria glauca*, *Poa bulbosa*, *Carex liparicarpos*, *Potentilla arenaria*, *Sedum sexangulare*, *Thymus serpyllum*, *Thymus marschallianus*, *Euphorbia cyparissias*, *E. seguieriana*, *Rumex acetosella*, *Peucedanum oreoselinum*, *Tunica saxifraga*, *Jasione montana*, *Erysimum diffusum* and *Hieracium pilosella* can be found. The abundant cryptogamous synusia of the meadow mainly consists of *Cladonia* species, *Cl. furcata*, *Cl. rangiformis*, *Cl. convoluta*, *Cl. cornutoradiata*, and in periodically differing masses of *Ceratodon purpureus* moss.

The soil of the grassland is slightly humic sand, its pH value changes in the vegetation period between 4.9—5.3 according to our measurements. Owing to its small organic and inorganic colloidal content, the bulk density of the slightly structured sandy soil is 1.45.

Methods

In order to follow the seasonal changes taking place in the phytomass, 11 adjoining pieces of monolith samples, 20×20×20 cm in size, were taken from the meadow monthly; along a transect. By harvesting the monoliths the aboveground parts were removed, sifting out the root system, homogenized soil samples of the monolith were collected for the laboratory examinations.

The phytomass was separated into the following fractions: aboveground living plant parts, standing dead parts, litter, cryptogamous phytomass and underground phytomass (roots). The weight of the various fractions was measured in air dry conditions.

For determining the organic matter content of the soil, TYURIN's $K_2Cr_2O_7$, wet oxidation was applied (ARINUSHKINA, 1961).

The pH value of the soil was measured by applying a glass-electrode in a suspension of distilled water and nKCl. The determination of bulk density was carried out by applying metal cartridges of known volume by measuring the weight of soil samples of original structure after drying them out (BALLENEGGER and DI GLÉRIA, 1962).

In the course of processing the phytomass fractions, the statistical analysis of the samples was carried out. For detecting the effect of the treatment, analyses of variance were applied (SVÁB, 1973).

The results of the examinations

The quantity of the total organic matter of the monoliths, its distribution among the different fractions, and its seasonal changes are shown in Fig. 2.

The total organic matter content of the monoliths is on the average between 100 and 110 g. This is slightly higher than can be measured in the perennial open meadow of the calcareous sandy soil, of the Danube-Tisza region (90—95 g average). Its quantity is the smallest in early springtime and in the course of the vegetation period it increases evenly. It reaches the maximum value by the end of the summer; by then some 30 t/ha living and dead organic matter accumulates in the perennial open acidic sandy meadow and in the upper 20 cm layer of its soil.

About one half of the organic matter of the monoliths consists of the organic matter of the soil, humus. Its concentration in the soil is between 0.4 and 0.6%, which corresponds to 50—70 g/monolith humus content. Its

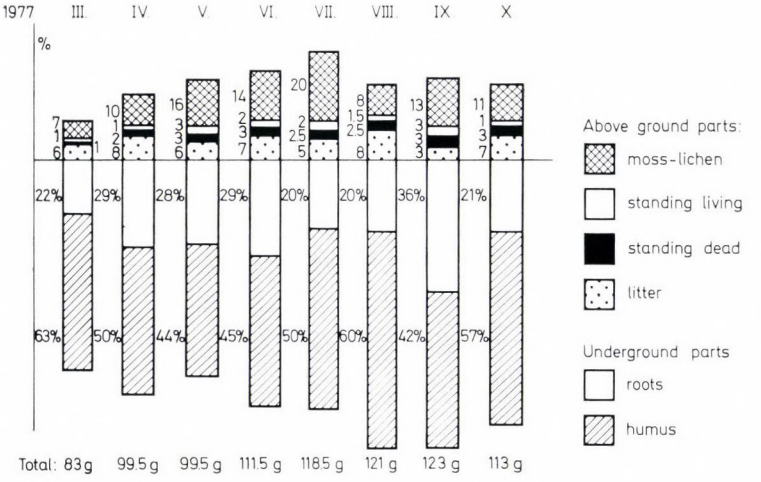

Fig. 2. Seasonal changes in the distribution of organic material (g/monolith) in the *Festuco vaginatae-Corynephoretum* meadow of Böhönye

share is the greatest at the beginning of the vegetation period, when the quantity of the phytomass is still of a rather small value. A maximum humus content can be observed in August as against the early-summer maximum of the meadows in the Danube-Tisza region (KOVÁCS-LÁNG, 1974).

Among the averages of the successive months, in June—July the significant difference appears at a 5% level; in July—August and September—October at a 1% level, while in August—September at a 0.1% level.

The analysis of variance indicates the effect of months to be significant at a 0.1% level.

By examining the quantity and distribution of the phytomass it can be stated that the dominance of the underground parts is characteristic.

Root phytomass makes up 20—30% of the total organic matter content of the monoliths. Its ratio changes in the course of the vegetation period. Starting with an early-spring low value, it shows an early summer increase, then a decrease in summer. The quantity of roots suddenly increases remarkably in September. When the root system comprises 36% of the organic matter content of the monoliths.

This is a noteworthy phenomenon because — as has been stated by PRÉCSÉNYI (1972), on the basis of his analysis of several authors' work — in meadow associations the maximum values of root phytomass occur most frequently at the beginning of the vegetation period, in April and May, while its minimum values most frequently appear in September. However, dynamics different from this can also be observed; cf. DAHLMAN and KUČERA (1965).

The ratio of the root system is often expressed by the root importance index, RII% (STRUIK, 1965). The root importance index gives the ratio of the root system to the total of flowering phytomass.

In the acidic sandy meadow, the root importance index had the following pattern in the vegetation period of 1977:

Months:	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
RII%	72.0	71.6	70.8	70.3	64.8	61.5	79.8	64.8

The values indicate that under the more humidic conditions of Inner-Somogy, the root mass receives a smaller part in the phytomass as a whole, than for example under the semi-arid conditions of the *Festucetum vaginatae danubiale* meadow growing in the Danube-Tisza region.

Our examinations at Csévharaszt brought RII values about 80% (KOVÁCS-LÁNG, 1974). The more arid the character of the climate the greater the role of the root system in relation to the total phytomass (BAZILEVICH and RODIN, 1968).

The samples of root phytomass from the acidic sandy meadow show a much greater variance than that could be observed previously at Csév-

haraszt. The value of CV is especially hight at the developmental stage of the root system.

Of the successive months, significant differences (1%) can be observed only in August—September and September—October.

The analysis of variance indicates that the effect of months is significant at 5% level.

The aboveground flowering phytomass makes up 8—12% of the total organic matter content of the monoliths. Its maximum quantities can be measured in summer, when the aboveground parts of the flowering plants (living, standing dead, litter) together represent some 5.5 t/ha dry weight. This means about 30—40% more aboveground organic matter content than can be measured in the Danube-Tisza region. Thus, the differences shown in the root importance indices of the meadows in the two regions are due to the greater quantity of the root system — at Csévharaszt — and to the greater quantity of the aboveground phytomass — at Böhönye.

Table 1

Seasonal changes in the organic matter content of the soil in the Festuco vaginatae-Corynephoretum meadow, Böhönye, 1977; humus g/8 dm³

Sampling time	$\overline{X}$ S	CV%
III. 28	52.32 ± 2.63	5.1
IV. 17	49.30 ± 4.08	8.2
V. 17	44.08 ± 4.90	11.1
VI. 20	49.90 ± 7.65	15.2
VII. 18	60.32 ± 4.06	6.7
VIII. 29	71.90 ± 9.81	13.5
IX. 19	52.20 ± 2.36	4.5
X. 17	64.30 ± 4.29	6.6

Signif. diff. 5% = 8.36
1% = 11.12
0.1% = 14.4

Analysis of variance table

Factor	SQ	FG	MQ
Total	3139.5	31	
Treatment	2405.3	7	343.62***
Error	734.2	21	34.96

F = 9.82
*** P < 0.1%

The quantity of the dead aboveground phytomass is rather high during the whole vegetation period. The quantitative changes in the standing dead parts are closely connected with those of the living parts, while the increase or decrease of the litter shows an opposite course to the former ones.

On the basis of the changes in the quantities of standing living parts it can be stated that the open perennial meadow of *Festuca vaginata* in Inner-Somogy — where the summer semi-arid period does not appear in the climate, but the sub-Mediterranean effect is definite — shows a double production maximum too. The early summer first maximum — appearing in general in June — in 1977 shifted to July, connected with the rainfall conditions. This was followed by decreased quantities of the living parts, and the considerable increase in litter in August. The second maximum, stronger in absolute values, can be observed in September.

On the basis of the process of increases in the aboveground parts; the annual aboveground phytomass production (that is the one which came about

Table 2

Seasonal changes in the root phytomass of the Festuco vaginatae-Corynephoretum meadow (Böhönye 1977); g/8 dm³

Sampling time	$\overline{X}$	S	CV%
III. 28	17.79 ±	3.76	21.1
IV. 17	29.20 ±	15.41	52.7
V. 17	27.62 ±	23.42	84.8
VI. 20	31.84 ±	17.90	56.2
VII. 18	22.25 ±	9.92	44.0
VIII. 29	23.37 ±	11.57	49.4
IX. 19	44.54 ±	14.22	31.9
X. 17	23.70 ±	11.12	46.9

Signif. diff. 5% = 13.78
1% = 18.35
0.1% = 23.75

Analysis of variance table

Factor	SQ	FG	MQ
Total	19,727.84	79	
Treatment	4,622.53	7	660.36***
Error	15,105.31	63	239.76

F = 2.75
*** P < 5%

Table 3

Seasonal changes in the aboveground flowering phytomass of the Festuco vaginatae-Corynephoretum meadow (Böhönye 1977); g/400 cm²

Sampling time	Standing living parts			Standing dead parts			Litter		
	$\bar{X}$	S	CV%	$\bar{X}$	S	CV%	$\bar{X}$	S	CV%
III. 28	0.58	± 0.25	43.0	1.12	± 0.21	18.5	4.78	± 1.34	28
IV. 17	1.27	± 0.59	47.0	2.07	± 0.98	47.6	8.38	± 3.20	38.2
V. 17	1.83	± 1.62	88.5	2.86	± 2.10	73.4	5.62	± 2.97	52.8
VI. 20	2.14	± 0.60	28.0	2.88	± 0.94	32.6	7.98	± 1.68	21.0
VII. 18	2.37	± 1.28	54.0	3.24	± 1.89	58.3	7.08	± 3.08	43.5
VIII. 19	1.91	± 1.29	67.8	2.96	± 1.16	39.2	10.47	± 3.41	32.5
IX. 19	2.53	± 1.09	43.1	3.89	± 1.82	46.7	4.08	± 2.73	67.0
X. 17	1.76	± 1.29	73.3	3.30	± 1.96	59.4	8.38	± 4.29	51.2
Signif. diff.	5% = 0.76 1% = 1.02 0.1% = 1.32			5% = 1.46 1% = 1.95 0.1% = 2.52			5% = 2.72 1% = 3.62 0.1% = 4.68		

Analysis of variance table

Standing living parts			
Factor	SQ	FG	MQ
Total	73.88	79	
Treatment	27.45	7	3.92***
Error	46.43	63	0.74

F = 5.32
*** P < 0.1%

Standing dead parts			
Factor	SQ	FG	MQ
Total	220.74	79	
Treatment	50.14	7	7.16*
Error	170.59	63	2.71

F = 2.64
* P < 5%

Litter			
Factor	SQ	FG	MQ
Total	955.34	79	
Treatment	366.88	7	52.41***
Error	588.46	63	9.34

F = 5.61
*** P < 0.1%

during the vegetation period) can be estimated. In the acidic sandy meadow examined by us, the NET production can be put at about 3.8 t/ha of dry matter.

In the statistical analysis of the data, significant differences appear only in the samples of litter in the averages of the successive months.

The analysis of variance shows, however, that the effect of months is significant at 0.1% level — as in the case of litter — in the living flowering parts as well.

The phytomass of the cryptogamous fraction appeared most significant in the acidic sandy meadow. Besides the Cladonia species dominant in the calcareous sandy steppe meadows (Csévharaszt), the phytomass amount of the mosses occasionally prevails. The phytomass of moss-lichen during the whole vegetation period surpasses that of the aboveground flowering plants. Their quantity is some 10—20% of the total organic matter content of the monolith.

Table 4

Seasonal changes in the cryptogamous phytomass of the Festuco vaginatae-Corynephoretum meadow (Böhönye 1977); g/400 cm²

Sampling time	$\bar{X}$	S	CV%
III. 28	6.22 ±	2.45	39.4
IV. 17	10.10 ±	6.40	63.3
V. 17	16.48 ±	12.06	73.1
VI. 20	15.98 ±	7.11	44.4
VII. 18	23.35 ±	9.56	40.9
VIII. 29	9.94 ±	3.22	32.4
IX. 19	16.36 ±	6.25	38.1
X. 17	11.74 ±	2.71	23.0

Signif. diff. 5% = 3.98
1% = 5.29
0.1% = 6.85

Analysis of variance table

Factor	SQ	FG	MQ
Total	5519.54	79	
Treatment	4260.53	7	608.65***
Error	1259.00	63	19.98

F = 30.45
*** P < 0.1%

Concerning their seasonal changes, the analysis of variance shows the effect of months significant at 0.1% level.

The rate of increasing or decaying process can be characterised well by the values of the productivity.

The daily productivity values of the phytomass in the sandy meadows of Inner-Somogy as calculated for both the total flowering phytomass, and the living parts are slightly higher than those obtained in the calcareous sandy meadows of drier climate in the Danube-Tisza region. In connection with this the energy utilisation values that can be calculated for the period of increase are also higher.

Table 5

The productivity of the aboveground flowering phytomass in the Festuco vaginatae-Corynephoretum meadow (Böhönye 1977); g/400 cm²/day

Period	Total of aboveground flowering parts	Standing living parts	Total of standing parts
III. 28—IV. 17 20 days	+0.2612	+0.0345	+0.0820
IV. 17—V. 17 30 days	−0.0476	+0.0186	+0.0447
V. 17—VI. 20 34 days	+0.0792	+0.0091	+0.0098
VI. 20—VII. 18 28 days	−0.0115	+0.0079	+0.0205
VII. 18—VIII. 29 42 days	+0.0807	−0.0110	−0.0220
VIII. 29—IX. 19 21 days	−0.1612	+0.0300	+0.0517
IX. 19—X. 17 28 days	+0.1046	−0.0277	−0.0486

Table 6

The ecological efficiency values of the Festuco vaginatae-Corynephoretum meadow (Böhönye 1977)

Period	Standing flowering parts, %
III—IV	0.30
IV—V	0.11
V—VI	0.02
VI—VII	0.04
VIII—IX	0.16

Note. For the estimation of the energy utilisation, the NET productivity of the standing parts and the values of global radiation were taken as a basis, by taking the calorific value of the phytomass as 167 000 J/g.

The phytomass production and the energy utilisation are influenced by different environmental factors.

The effect of climatic elements and of certain soil characteristics will be analysed in the second part of our paper.

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REGIONALE WALDENTWICKLUNGSTYPEN, INSBESONDERE IN DEN ALPEN

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The needle-leafed forests of the Alpes can be regionalized into two large zones based on their actual composition and postglacial development. The inneralpine coniferous zone is formed by fir- and spruce-forests. It is divided into two subzones: the western-alpine subzone is characterized by the dominance of fir-woods (*Abietetum*), in the eastern-alpine subzone a regular zonal distribution of fir- and spruce-woods (*Piceetum*) can be found. In the borderland of the Alpes extending fir-beech zone (*Abieti-Fagetum*) can be divided into several regional (provençale, helvetian, upper-italian, north-alpine and illyrian) types having well marked, different palynological evidences in their postglacial development.

Schon seit den Anfängen der waldgeschichtlichen Forschung auf pollenanalytischer Grundlage galt das besondere Bemühen der Herausarbeitung von Waldentwicklungstypen, die nicht in erster Linie für einen lokalen Bereich, sondern für eine weitere Region charakteristisch sein sollten. Die Kennzeichnung der einzelnen Schritte der Waldentwicklung muß in diesem Fall auf die gemeinsamen Züge der zu erfassenden Region abgestimmt sein, nur zur Unterscheidung von Entwicklungsvarianten können auch relativ lokale Details zweckdienlich sein.

Ohne Zweifel der bekannteste, schon in fast unzähligen Arbeiten für einen ersten Einstufungsversuch von Pollendiagrammen herangezogene regionale Typ ist die von RUDOLPH (1930, »historische Grundsukzession«) erkannte »mitteleuropäische Grundfolge der Waldentwicklung« (FIRBAS, 1949). Die für die mitteleuropäische Eichen-Buchenwaldregion charakteristische Abfolge von »Waldzeiten« beginnt mit Birke und Kiefer, wird durch Hasel und Eichenmischwald abgelöst und schließt mit der späten Ausbreitung der Buche. In den einzelnen Landschaften wird diese Grundfolge durch unterschiedliche Einschaltung anderer Baumarten, wie der Fichte, Tanne und Hainbuche, modifiziert. Dies gilt vor allem für die Mittelgebirge und natürlich auch für die Alpen.

Westlich des Alpenbogens (Westeuropäische Laubwaldregion) findet sich die typische Abfolge (z. B. Französisches Zentralmassiv, LANG u. TRAUTMANN, 1961; LANG, 1970), im Osten und Süden (Ost- und Südosteuropäische Laubmischwaldregion) ist sie in Form von Modifikationen noch ziemlich deutlich zu erkennen. So setzt z. B. in der Ungarischen Tiefebene (Balaton, ZÓLYOMI, 1953) und in Slowenien (ŠERCELJ, 1966) die Einwanderung der Buche erheblich früher ein als nördlich der Alpen, und in der Lombardei (BERTOLDI, 1968) folgt auf eine Kiefernzeit die bis zur Gegenwart dauernde Eichenmischwald- (EMW-) Zeit. Nicht mehr zu erkennen ist die mitteleuropäische Grundfolge dagegen in der mediterranen Hartlaubregion (z. B. Süddalmatien, BEUG, 1961). Einen großen Fortschritt brachte die Radiokarbonmethode auch für die regionalen Waldentwicklungstypen, da erst mit ihrer Hilfe durch absolute zeitliche Einstufung die Parallelisierung der Entwicklung in verschiedenen Landschaften gelang.

Eine mit Schwerpunkt auf die *montane Höhenstufe der Alpen* (Nadelmischwaldregion) gerichtete Auswertung ergibt im Vergleich zur Entwicklung im nördlichen submontan-kollinen Vorland des Gebirges wesentliche Unterschiede (KRAL in MAYER, 1974):

— Die Abschnitte der mitteleuropäischen Grundfolge gelangen in der Regel nur in stark abgeschwächter Form oder überhaupt nicht zur Ausprägung.
— In den Ostalpen kommt die Fichte, in den Westalpen die Tanne schon früh zur Vorherrschaft, die in größeren Teilen der Alpen in der Regel bis in die jüngste Vergangenheit beibehalten wird.
— Der boreale Haselgipfel ist nur am nordwestlichen Alpenrand deutlich ausgebildet, in den Zentralalpen fehlt er in der Regel ganz.
— Die atlantische EMW-Zeit des mitteleuropäischen Flachlandes prägt sich nur am nördlichen Alpenrand teilweise noch aus.
— Der subboreale Anstieg von *Fagus* kennzeichnet die Unterwanderung der Nadelwälder, zu einer ausgesprochenen Buchenzeit kommt es in der montanen Stufe aber nur in lokalen Ausnahmefällen.
— Der Einfluß des Menschen führt zum Rückgang der Tanne (Buche) und in der Regel zur erheblichen Zunahme des Fichtenanteils.

Nur der nordwestliche und nördliche Alpenrand schließen sich somit in mancher Hinsicht noch an die mitteleuropäische Grundsukzession an. Insgesamt lassen die zwischen Nord-, Zentral- und Südalpen bzw. Ost- und Westalpen bestehenden Entwicklungsunterschiede für den Alpenraum auf eine relativ große Zahl regionaler Typen schließen. Eine zusammenfassende Gegenüberstellung der postglazialen Entwicklung in den *Ost- und Westalpen* läßt die unterschiedliche Rolle von Fichte und Tanne (LÜDI, 1955), aber auch von Buche deutlich erkennen:

— Die Massenausbreitung der Fichte im Osten bzw. der Tanne im Westen erfolgt im großen und ganzen während der Mittleren Wärmezeit. Die diesbezügliche Grenzlinie verläuft von den westlichen St. Galler und Glarner Alpen südostwärts durch Mittelbünden zu den Bergamasker- oder Adamello-Alpen (ZOLLER, 1960).
— Während der Späten Wärmezeit breitet sich die Tanne auch in den Ostalpen stärker aus und erreicht dort einen beachtlichen Höchststand. Umgekehrt setzt in den Westalpen zur gleichen Zeit die stark verzögerte Ausbreitung der Fichte ein, in den meisten Fällen schon durch frühen Einfluß des Menschen mitbedingt (MARKGRAF, 1970).
— Die Buche wandert in die randlichen Ostalpen früher ein als in die entsprechenden Teile der Westalpen; die Zentralalpen werden auch während des subatlantischen Höchststandes von der Buche nicht erreicht.
— Unter dem Einfluß des Menschen bleibt die Tanne in den Westalpen besser erhalten als im Osten, die Buche in den Ostalpen stärker vertreten als im Westen.

Die im einzelnen sehr unterschiedliche Entwicklung am Alpenrand erfährt beim Fortschreiten in das Alpeninnere insofern einen entscheidenden Wandel, als sie schließlich nur noch von Nadelbäumen bestimmt wird. Für die Abgrenzung der zentralen Alpen dient daher zweckmäßigerweise die den Höchststand der Buchenverbreitung anzeigende Grenze im Älteren Subatlantikum (Abb. 1). Ein »Ostalpiner« und ein »Westalpiner« Typus der »inneren Nadelwaldzone« ergibt sich aus der unterschiedlichen Rolle von Fichte und Tanne. Am Alpenrand zeichnen sich nach dem gegenwärtig schon möglichen großräumigen Überblick fünf Haupttypen regionaler Waldentwicklung ab, die durch breite Übergangszonen miteinander verbunden sind. In den Ost-

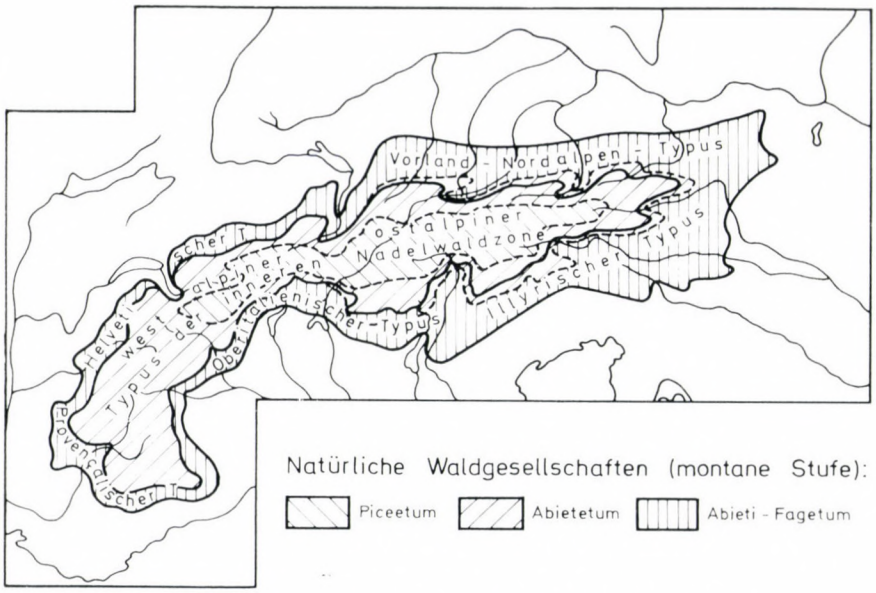

Abb. 1. Typen regionaler Waldentwicklung in den Alpen

alpen kann neben der »inneren Nadelwaldzone« auf den »Vorland-Nordalpen-«, »Illyrischen« und »Oberitalienischen Typus« KIELHAUSERS zurückgegriffen werden (in SCHARFETTER, 1938), auf die damals nach quantitativen, auf nur wenige Arten gestützten pflanzengeographischen Gesichtspunkten geschlossen wurde. Durch das heute weitaus umfangreichere pollenanalytische Grundlagenmaterial können diese Typen jetzt bestätigt und waldgeschichtlich viel besser gekennzeichnet werden. Für die Westalpen bieten sich zur Ergänzung der Übersicht noch zwei weitere, ein »Helvetischer« und ein »Provençalischer Typ«, an.

Unterlegt man der Karte der *regionalen Waldentwicklungstypen* der Alpen die Areale der natürlichen (Haupt-) Waldgesellschaften (MAYER, 1974), so wird deutlich, daß auch zwischen Alpenrand und Alpeninnerem fließende Übergänge bestehen. So kam z. B. die Buche im Osten während ihres subatlantischen Höchststandes nicht nur im »randalpinen« *Abieti-Fagetum*, sondern auch in Teilen des »zwischenalpinen« *Abietetums* vor. Auf der anderen Seite bilden die zentraler gelegenen, stets buchenfreien *Abietetum*-Gebiete den Übergang zum »inneralpinen« *Piceetum*.

Die Zahl von nur 7 regionalen Waldentwicklungstypen für die montane Stufe der Alpen scheint im Hinblick auf die große lokale Vielfalt gering. Ohne Zweifel wird jedoch durch eine relativ kleine Typenzahl die Übersicht des weitraumigen Gebietes besser erreicht. Das gleiche gilt auch für die Charakterisierung der Typen nach waldgeschichtlichen Kriterien, wobei die Unterschiede besser hervortreten.

a) Ostalpiner Typus der inneren Nadelwaldzone:

— Die präborealen Kiefernwälder werden im großen und ganzen während des Boreals von Fichte unterwandert, die seither vorherrschende Baumart ist.

— Die Tanne breitet sich im Subboreal vorübergehend bis weit in die eigentlichen Innenalpen hinein aus.

— Seit Beginn des Subatlantikums einsetzender Arealverlust der Tanne führt zu einer tannenfreien Fichten-Innenzone.

b) Westalpiner Typus der inneren Nadelwaldzone:

— In die Kiefernwälder des frühen Postglazials wandert die Tanne zum Teil schon im Boreal ein.

— Im Atlantikum ist die Tanne in der Regel bereits dominierende Baumart.

— Erst relativ spät und schon ± anthropogen setzt die Ausbreitung der Fichte ein, aber nur zum Teil kommt es zur Entstehung fichtenreicher Wälder.

c) Illyrischer Typus:

— Die schon im Präboreal in den Südostalpen vorkommende Fichte wird während des Boreals zumindest in dem an die Nadelwald-Innenzone grenzenden Übergangsbereich vorherrschende Baumart.

— Während der Mittleren Wärmezeit entstehen Fichten-Tannen-Buchenwälder, die vom Jüngeren Atlantikum an teilweise bis an die Grenze zur inneren Nadelwaldzone vorkommen.

— Nach dem Rückgang der Buche von ihrem subatlantischen Höchststand vermittelt eine stellenweise relativ breite Fichten-Tannwaldzone den Übergang zur Innenzone.

d) Oberitalienischer Typus:

— Nach Ablösung der Kiefernwälder dominieren im frühen Postglazial in den tieferen (randlicheren) Lagen der EMW, in den höheren Teilen tannenreiche Wälder.

— Zur Ausbildung von Fichten-Tannen-Buchenwäldern kommt es erst im Subboreal.

— Nach dem Rückgang der Buche bildet auch in diesem Fall eine Fichten-Tannenwaldzone den Übergang zur Innenzone.

e) Vorland-Nordalpen-Typus:

— Im Boreal sind die präborealen Kiefernwälder praktisch schon vom EMW abgelöst (im Westen höhere Haselwerte), während sich in den höheren Lagen (Übergang zur Innenzone) die Fichte ausbreitet.

— An der Wende Atlantikum/Subboreal wird der Fichten-Tannen-Buchenwald vorherrschend.
— Nach dem Rückgang der Buche leiten vom späteren Subatlantikum an Fichten-Tannenwälder zur Innenzone über.

f) Helvetischer Typus:

— Nach früher Unterwanderung der präborealen Kiefernwälder herrscht durch lange Zeit der EMW vor (extrem hohe Haselwerte im Boreal).
— Tannenreiche Wälder finden sich teilweise schon im ausgehenden Atlantikum, oft aber erst im Subboreal.
— Fichten-Tannen-Buchenwälder werden nur ausnahmsweise (lokal) schon vor dem Subatlantikum vorherrschend.

g) Provençalischer Typus:

— Wie beim Oberitalienischen Typus sind im frühen Postglazial für die tieferen Lagen der EMW, für die höheren tannenreiche Wälder charakteristisch.
— Während des Atlantikums und Subboreals wird der EMW durch die Tanne zunehmend zurückgedrängt.
— Zur Ausbildung von Buchen-Tannenwäldern (im wesentlichen ohne Fichte) kommt es erst im Subatlantikum.

Aus dem zusammenfassenden Vergleich (Tabelle) ergibt sich, daß bei den ostalpinen regionalen Entwicklungstypen spätestens im Boreal die Fichte überall schon als Waldbildner auftritt, während in den Westalpen die Tanne frühestens erst im Älteren Atlantikum diese Rolle übernimmt. Von den nur bei den randalpinen Typen aufscheinenden Laubbäumen tritt der EMW durchwegs vom Boreal an stärker auf, die Buche als Waldbildner frühestens im Jüngeren Atlantikum. Der Einfluß des Menschen führt in allen Fällen zur Zunahme von Fichte (Kiefer) und zum Rückgang von Tanne (Buche).

Der Illustration der unterschiedenen regionalen Waldentwicklungstypen dient eine Auswahl vereinfachter, auf einen einheitlichen absoluten Zeitmaßstab gebrachter *Pollendiagramme* aus der montanen Stufe der Alpen (Abb. 2). Dabei darf freilich nicht außeracht gelassen werden, daß jedes Einzeldiagramm neben den regionalen auch stets $\pm$ deutlich ausgeprägte lokale Züge enthält. So erreicht z. B. *Abies* im Diagramm aus dem Lungau sogar im Subboreal kaum 5% und im Wallis, wo die Tanne erst relativ spät einwandert, erfolgt der Anstieg von *Abies* — abweichend von der durchschnittlichen Entwicklung — erst an der Wende VI/VII.

Abschließend wird noch auf Abwandlungen der montanen Waldentwicklung in anderen Höhenstufen der Alpen verwiesen. In der *subalpinen* Stufe der Randketten stimmt die Entwicklung mit jener in der montanen

Tabelle 1

Regionale Waldentwicklungstypen

Zeitabschnitte	Östliche	Westliche	Illyrisch
	innere Nadelwaldzone		
X	Fi	Fi(-Ta)	Fi(-Ta-Bu)
IX	Fi(-Ta)	Ta-Fi	Fi-Ta-Bu
VIII	Fi-Ta	Ta	Fi-Ta-Bu
VII	Fi(-Ta)	Ta	Fi-Ta-Bu
VI	Fi(-Ki)	Ta-Ki	Fi-EMW(-Bu)
V	Fi-Ki	Ki(-Ta)	Fi-EMW
IV	Ki	Ki	Ki-Fi

Stufe in den Grundzügen in der Regel noch weitgehend überein, in den höheren Lagen kommt es jedoch infolge Ausfalles der anspruchsvolleren Baumarten zur zunehmenden Angleichung an die Entwicklung in der anschließenden inneren Nadelwaldzone. In vielen subalpinen Pollenprofilen aus den Ostalpen behält die Fichte vom Boreal bzw. Atlantikum an ihre hohen Werte praktisch bis zur Gegenwart bei, während sich Tanne und Buche im wesentlichen nur noch als Weitflug in den Diagrammen abzeichnen (MAYER, 1966, FRITZ, 1967). Auch in den Zentralalpen schließt die Entwicklung zumindest in tiefsubalpiner

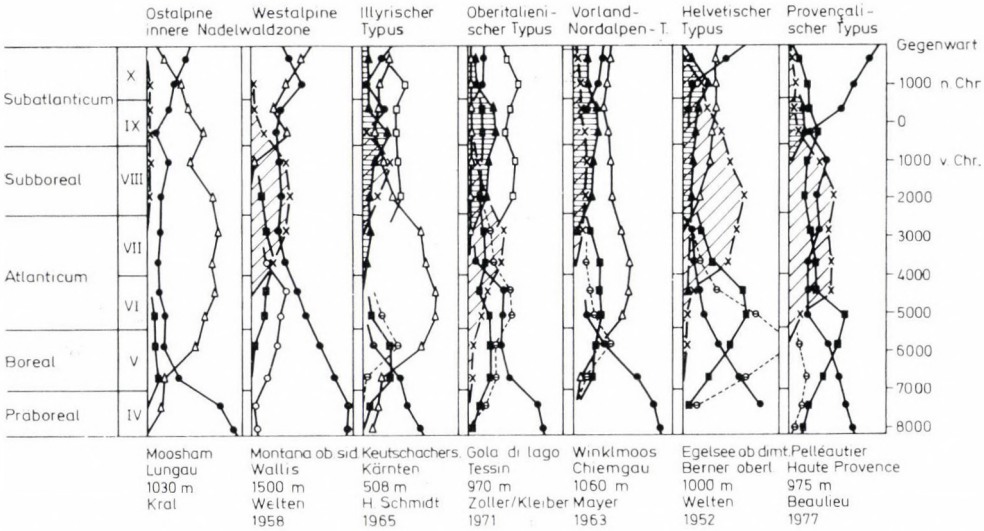

Abb. 2. Vergleich der Waldentwicklung an ausgewählten Beispielen aus der montanen Stufe der Alpen (stark vereinfachte Pollendiagramme). Schwarze Kreise: *Pinus*, schwarze Quadrate: *Quercetum mixtum*, schwarze Rhomben: *Corylus*, weiße Dreiecke: *Picea*, schwarze Dreiecke: *Fagus*, Kreuze: *Abies*

in den Alpen (montane Stufe)

Oberitalienisch	Vorland-Nordalpen	Helvetisch	Provençalisch
Fi(-Ta-Bu)	Fi(-Ta-Bu)	Fi(-Ta-Bu)	Ki(-Ta)
Fi-Ta-Bu	Fi-Ta-Bu	Fi-Ta-Bu	Ta-Bu(-Ki)
Ta-Fi-Bu	Fi-Ta-Bu	Ta-Fi-Bu	Ta-EMW
Ta-EMW	Fi-EMW(-Ta)	Ta-EMW	Ta-EMW
EMW-Ta	Fi-EMW	EMW	EMW-Ta
Ki-EMW-Ta	Fi-EMW	(Hasel-)EMW	Ki-EMW(-Ta)
Ki(-EMW)	Ki	Ki	Ki(-EMW)

Lage noch eng an jene in der montanen Stufe an (Lungau, BORTENSCHLAGER, 1967). Mit weiter zunehmender Seehöhe kommt es fast überall zu einem Ansteigen von *Pinus*; in der hochsubalpinen Stufe wird für den größten Teil der Alpen vom frühen Postglazial an schon die gegenwärtige Lärchen-Zirbenschlußwaldgesellschaft belegt (Venedigergebiet, BORTENSCHLAGER und PATZELT, 1969; Wallis, MARKGRAF, 1969). Auf der anderen Seite ist auch in den *submontan-kollinen* Lagen am Alpenrand in der Regel der Entwicklungstyp der montanen Stufe noch zu erkennen, wobei naturgemäß EMW und Buche stärker im Vordergrund stehen. Mit zunehmender Entfernung vom Gebirge zeichnet sich die mitteleuropäische (submontan-kolline) Grundsukzession immer deutlicher ab, im Umkreis der Alpen in den jeweiligen — eingangs erwähnten — besonderen Ausbildungsformen.

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DIGITALIS LANATA EHRH. IN THE BUDA-PILIS RANGE OF MOUNTAINS (NEAR TO BUDAPEST)

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Digitalis lanata Ehrh. is a cultivated medicinal plant in Hungary. Its occurrence in the Buda-Pilis range of mountains (near to Budapest) has been being discussed, whether it would be spontaneous or escaped from cultivation. Phytocenological studies of its localities demonstrate, this species occurs as a native member of natural plant communities. It is a Balkan-Pannonian element tolerating favourably anthropic influences.

On its occurrence Soó (1968) writes: "Its spontaneous occurrence in the Pilis-Buda range of mountains seems — in opposition to my earlier view — nevertheless possible since it grows also in rock swards and in karstland forests." Then he adds that no coenological data has appeared on the plant in Hungary. The work of ZÓLYOMI (1958), surveying the natural plant cover of Budapest and its environs in detail, does not report on such coenological sampling either in which this plant would have appeared. The dissertation of SZABÓ (1939) surveys with a sketch map its occurrence as an officinal plant in the Carpathian Basin, on the basis of data from herbarium and the literature.

We have made 23 samplings in habitats occurring in the environs of Budapest, always in such plant communities where *Digitalis* was also present. The fields of survey of 5×5 m (25 m^2), in which the presence of the plants was marked by BRAUN-BLANQUET-scale (that is, $+ = 1\%$, $1-5\%$, $2 = 25\%$, $3 = 25-50\%$, $4 = 50-75\%$, $5 = 75-100\%$ coverage of the area).

The enumeration of the species is shown in the order of the frequency of occurrence; the species occurring in the 23rd sampling are given only once in continuous enumeration (the sampling in which it occurred is marked).

Samplings 1—5: taken on July 20, 1958, beyond Árpádfürdő, at Csillaghegy. Its basic rock is limestone of Dachstein. Immediately beyond the settlements, in strongly weedy degraded areas, on the thin layered soil, in the 0—10 cm stratum, the pH varied between 7.4 and 7.7 (expressed in H_2O and KCl it was 6.2—6.8). The cover of *Digitalis lanata* in the period of its full blossoming is sporadically mixed with broken stones; in areas which are only sporadically covered by shrub the plant reached a coverage of even 8—10%.

Samplings 6—8: Taken on August 12, 1958, beyond the village of Üröm. In place of a neglected, weedy orchard of peaches, the remnants of vinestocks growing wild were also found here; the seondary grassland consisted of *Agropyron intermedium* and *Cynodon dactylon;* in plant communites with a small number of species, *Digitalis* deflorescenced.

Samplings 9—11: Taken on August 12, 1958, also beyond Üröm. In the *Pinus nigra* wood planted on the south-eastern side of Nagykevély, *Digitatalis* occurs in abundance, its coverage reaches as much as 25% a square; in the herb layer, *Festuca* is predominant.

Samplings 12—15: Taken on August 16, 1958, beyond Békásmegyer; samplings 12—13 on the side of Ezüsthegy, at the boundary of an acacia grove sloping in a north-eastern direc-

Fig. 1. Digitalis lanata habitat in Ezüsthegy, beyond Budakalász

Fig. 2. Digitalis lanata at the entrance of the sandstone quarry of Ezüsthegy

Fig. 3. Digitalis lanata on the ridge of the sandstone quarry (Mount Pilis)

tion; in certain areas even as many as 10 plants of *Digitalis* occurred in 1 m². Sampling 14 was taken from an area covered with grassland and with avalanche of stones, sloping towards an eastern direction; sampling 15 was taken from an area of north-eastern slope of stony pine-wood (*Pinus nigra*), rich in *Digitalis lanata;* its coverage reaches even 25—50% and there was such a spot where we could count 105 plants of *Digitalis lanata* in 10 m².

Samplings 16—23 were taken in co-operation with academician, Dr. B. Zólyomi on June 19, 1974. Samplings 16—21 were made in stands beyond Békásmegyer, occurring in rock beds of Dachstein limestone and more or less disturbe soils. At the edge of the forest (sampling 16), the plants were only buds yet, while in the more disturbed fallow land of *Arrhenatheretum* we could observe 1 m high flowering plants. Sampling 18 indicates a stand of *Hieracium pilosella* cover in 50—60% of a fallowed grassland section. Sampling 19 is taken from a drying grassland of 50—70% *Festuca* coverage. Sampling 20 also showed a closed and even more balanced state of stand; here the surface layer is somewhat more above, and *Euphorbia panmonica*, which is of an identical floral element with that of *Digitalis lanata*, reached a coverage of 25—50%. The surface of sampling area No. 21 was stony-rocky and its vegetation indicated a forest boundary.

Sampling 22 was made at the fringe of the sandstone quarry of Ezüsthegy-Hárshegy where originally *Quercetum petraeae-cerris* had been planted. *Fraxinus ornus* and *Cerasus mahaleb*, which is to be found there at present, was planted secondarily after the felling of the forest. Possibly, on the southern slope there was *Orno-Quercetum* (B. Zólyomi). On the rocks, the herb layer hardly reaches 20% of the coverage, while the ground layer is at least a 50% cover. Sampling 23 shows a very peculiar picture (see Photo) of the vegetation formed on the deposit (unproductive) at the entrance of the sandstone quarry: *Fraxinus ornus*, *Cornus sanguinea*, with *Cerasus mahaleb* shrubs and *Digitalis lanata*, and with *Verbascum speciosum* which is a biennial species of Balkan-Pannonian origin.

The ecological spectrum which is compiled on the basis of either the whole species list (species list-species occurring only once) or species occurring at least twice in the sampling indicates differences in the frequency of some

Table 1

Samples of plant communities with

	Number								
	1	2	3	4	5	6	7	8	9
Digitalis lanata	+	+−1	+	+	1−2	+−1	+	+−1	2
Festuca sulcata-valesiaca	+	+	—	3	+	—	+	+	3
Sanguisorba minor	—	1−2	+	1−2	+	—	+	1−2	+−1
Centaurea micranthos	+	—	+	+	—	+	+−1	—	1
Achillea neilreichii	—	—	—	—	—	+	+	2	+−1
Lotus corniculatus	—	+	+	+	+	—	+	+−1	+
Linaria genistifolia	—	—	—	—	—	1	+	+	+
Eryngium campestre	—	—	+	—	—	—	—	—	+
Stachys recta	+	1−2	1	1−2	—	—	+	—	+
Arrhenatherum elatius	1	1−2	+	+	1	—	—	—	—
Carlina brevibracteata	+	+	—	+	+	—	+	—	—
Seseli osseum	—	—	+	—	—	—	—	+	+−1
Galium verum	—	—	—	—	+	—	—	—	—
Crataegus monogyna	—	+	+	+	+	—	—	—	—
Melica ciliata	—	—	—	—	+	+	—	—	+
Euphorbia pannonica	—	—	+	—	—	—	—	+	+
Coronilla varia	+−1	+	—	+	—	—	—	+	—
Linum tenuifolium	—	+	+	+	—	—	—	—	+
Prunus spinosa	—	—	—	—	+	—	—	+	—
Centaurea sadleriana	—	+−1	+	+	—	—	—	—	+
Xeranthemum annuum	—	—	—	—	—	+	2	+−1	—
Cytisus austriacus	—	—	—	—	—	—	—	+	+
Koeleria gracilis	—	+	+	+−1	—	—	—	—	—
Satureja acinos	—	—	—	—	—	—	—	—	—
Melilotus officinalis	+	+	+	—	+	—	—	—	—
Picris hieracioides	+	—	—	—	—	+	2	+	—
Astragalus onobrychis	—	+	+	+−1	+−1	—	—	—	—
Pinus nigra	—	—	—	—	—	—	—	—	+
Dactylis glomerata	—	+	+	+	1−2	—	—	—	—
Dorycnium herbaceum	+	+	4	—	2	—	—	—	—
Asperula cynanchica	—	+	—	—	—	—	—	—	—
Hieracium bauhinii	—	—	—	—	—	—	—	—	—
Teucrium chamaedrys	—	—	—	—	—	—	—	—	+−1
Anthemis tinctoria	—	—	—	—	—	1	—	—	—
Sedum boloniense	—	—	—	—	—	—	—	—	+
Echium vulgare	—	—	—	—	—	+	—	+	+
Ononis spinosa	+−1	2−3	1−2	—	—	—	—	—	—
Achillea millefolium	+	+	—	+	—	—	—	—	—
Daucus carota	+	—	—	—	+	—	+	—	—
Cerasus mahaleb	—	—	—	—	—	—	—	—	—
Rosa canina	—	—	—	+	—	—	—	—	—
Andropogon ischaemum	—	—	—	—	—	+	—	—	—
Hieracium pilosella	—	—	—	—	—	—	—	—	—
Linaria vulgaris	+	+	—	—	—	—	—	—	—
Agrimonia eupatoria	—	—	—	—	—	—	—	—	—
Thymus serpyllum s. l.	—	—	—	—	—	—	—	—	—
Minuartia glomerata	—	—	—	—	—	—	—	—	—
Anthyllis polyphylla	—	+	—	—	—	—	—	—	—
Cynodon dactylon	3−4	1	—	—	—	—	2	—	—
Bupleurum falcatum	+	+	+	+	—	—	—	—	—
Cornus mas	+	+	+	—	—	—	—	—	—
Cornus sanguinea	—	—	—	—	—	—	—	—	—
Quercus cerris	—	—	—	—	—	—	—	—	—
Quercus pubescens	—	—	—	—	—	—	—	—	—
Fraxinus ornus	—	—	—	—	—	—	—	—	—

the presence of Digitalis lanata

of the samples

10	11	12	13	14	15	16	17	18	19	20	21	22	23
2	+−1	+	+−1	1	2−3	+	+	1	+	1	+−1	+	2
2−3	2	+	+	−	3	+	+	1−2	4−5	4	2−3	+	+
+−1	1−2	2	−	+−1	+−1	+	+	+	−	+−1	+	−	+
+	+−1	+	+−1	+	+	−	+	−	−	+	−	+	−
+	+	+−1	−	−	−	+	+	+	+	+	+	+	2
+	+−1	+	−	−	+−1	−	−	−	−	+	+	−	+
+	−	+	+	+	+	−	−	−	−	+	+	+	+
+	−	+−1	−	+	+	−	+	+−1	2	−	+	1	1
−	+	−	+	+	−	−	−	+	1	+	−	−	−
−	−	−	+	−	−	+	4	+	−	+	+	−	−
−	−	+	1	+	−	−	+	−	−	−	−	+	−
1−2	1−2	−	+	+−1	1	−	−	−	−	+	−	−	+
−	−	+	+	2	−	−	+	+	1	−	+	+	−
−	−	−	+	−	−	+	−	−	−	−	+	+	−
+	−	−	−	−	+	−	−	+	+	−	−	+	+
−	+	−	−	−	+−1	+	−	−	−	3	+	−	−
−	−	−	−	−	−	−	−	+	+	+	−	+	−
−	−	−	+	−	−	−	−	+	+	1	−	−	−
1−2	−	−	−	+	−	−	−	+	+	−	−	+	−
+	−	−	−	−	+	−	−	−	−	−	+	−	−
+	−	1−2	+−1	−	−	−	−	−	−	−	−	−	+
−	+	−	−	+	−	+	−	−	−	−	+	+	−
−	−	−	−	−	−	−	−	−	−	+	+	−	+
−	−	−	−	−	−	+	+	+	+	+	+	−	−
−	−	−	+	−	−	−	+	−	−	−	−	−	−
−	−	−	1	−	−	−	−	−	−	−	−	−	−
−	−	−	−	1	−	−	−	−	−	+	−	−	−
−	+	−	−	−	+	+	−	−	−	−	+	−	−
−	−	−	+	−	−	−	−	−	−	−	−	−	−
−	−	−	−	−	−	−	−	−	−	−	3	−	−
−	+	−	−	−	+	−	−	+	+	−	−	−	−
−	−	−	−	−	−	−	−	+	+	1	+	+	−
+	−	−	−	−	−	−	−	+	+	+	−	−	−
−	−	−	−	−	−	−	−	+	+	+	+	−	−
−	+	−	−	−	+	−	−	−	−	+	+	−	−
−	−	+	−	−	−	−	−	−	−	−	−	−	+
−	−	+	−	−	+	−	−	−	−	−	−	−	−
−	−	+	−	−	+	−	−	−	−	−	−	−	−
−	−	+	+−1	−	−	−	−	−	−	−	−	−	−
−	−	−	−	−	−	+	−	−	−	−	+	+	+
−	−	−	−	−	−	−	−	−	+	+	−	+	−
1	−	+	+−1	−	−	−	−	−	−	−	−	+	−
−	−	−	−	−	−	+	−	2	+	−	−	2	−
−	−	−	+	−	−	−	1	−	−	−	−	−	−
+	−	−	+	+	−	−	+	−	−	−	−	−	−
+	−	−	−	−	−	−	+	−	−	+	−	−	+
−	+	−	−	−	+	−	−	+	+	−	−	−	−
+	−	−	3−4	−	+	−	−	−	−	−	−	−	−
−	−	+−1	−	−	−	−	−	−	−	−	−	−	−
−	−	−	−	−	−	−	−	−	−	−	−	−	−
−	−	−	−	−	−	−	−	−	−	−	−	−	−
−	−	−	−	−	−	−	−	−	−	−	+	+	+
−	−	−	−	−	−	+	−	−	−	−	+	+	−
−	−	−	−	−	−	−	−	−	−	−	+	+	+
−	−	−	−	+	−	−	−	−	−	−	−	+	+

Table 1 (cont.)

	Number								
	1	2	3	4	5	6	7	8	9
Poa angustifolia	—	—	—	—	—	+	—	—	—
Anthoxanthum odoratum	—	—	—	—	—	—	—	—	—
Agropyron intermedium	—	—	—	—	—	3	—	—	—
Ajuga chamaepitys	+	—	—	—	—	—	—	—	—
Stachys recta	—	—	—	—	—	—	—	—	—
Reseda inodora	—	—	—	—	—	—	—	—	—
Alyssum alyssoides	—	—	—	—	—	—	—	—	—
Plantago lanceolata	—	—	—	—	—	—	—	—	—
Sideritis montana	—	—	—	—	—	—	—	—	—
Solidago virga-aurea	—	—	—	—	—	—	—	—	—
Euphorbia cyparissias	—	—	—	—	—	—	—	—	—
Lactuca perennis	—	—	—	—	—	+	—	—	—
Potentilla recta	+	+	—	—	+	—	—	—	—
Falcaria vulgaris	—	—	—	+	+	+	—	—	—
Vitis vinifera	—	—	—	+	—	—	—	—	—
Robinia pseudo-acacia	—	—	—	—	+	—	—	—	—
Quercus petraea	—	—	—	—	+	—	—	—	—
Rubus caesius	—	—	—	—	+	—	—	—	—
Calamagrostis epigeios	—	+	+	—	—	—	—	—	—
Agropyron repens	—	—	—	—	—	—	—	—	—
Melica transsilvanica	—	—	—	—	—	—	—	—	—
Filipendula hexapetala	—	—	—	—	—	—	—	—	—
Crupina vulgaris	—	—	—	—	—	—	—	—	—
Caucalis daucoides	—	—	—	—	—	+	—	—	—
Lathyrus tuberosus	—	1—2	—	—	—	—	—	—	—
Carduus nutans	—	—	—	—	—	—	—	+	—
Nonea pulla	—	—	—	—	—	—	—	—	—
Potentilla argentea	—	—	—	—	—	—	—	—	—
Medicago falcata	—	—	—	—	—	—	—	—	—
Globularia elongata	—	—	—	—	—	—	—	—	—
Fragaria moschata	—	+—1	—	—	—	—	—	—	—
Hypericum perforatum	+	—	—	—	—	—	—	—	—
Verbascum speciosum	—	—	—	—	—	—	—	—	—
Tunica prolifera	—	—	—	—	—	—	—	—	—
Convolvulus cantabricus	—	—	—	—	—	—	—	—	—
Stipa capillata	—	—	—	—	—	—	—	—	+
Salvia nemorosa	+	—	—	—	+	—	—	—	—
Clematis vitalba	—	+	—	+	—	—	—	—	—
Campanula sibirica	—	—	+	—	—	—	—	—	—
Prunus persica	—	—	—	—	—	3	+	—	—
Nigella arvensis	—	—	—	—	—	—	+	+	—
Verbascum phlomoides	—	—	—	—	—	—	—	—	+
Allium flavum	—	—	—	—	—	—	—	—	+
Allium montanum	—	—	—	—	—	—	—	—	+

Species occurring in a single sample:

Rapistrum perenne (1), *Euphorbia falcata* (1), *Colutea arborescens* (3), *Silene longiflora* (3), *Poa angustifolia* (6), *Artemisia campestris* (6), *Sedum maximum* (6), *Scabiosa ochroleuca* (5), *Senecio jacobaea* (9), *Onosma visianii* (9), *Allium sphaerocephalum* (10), *Iris variegata* (10), *Teucrium montanum* (10), *Silene otites* (15), *Consolida regalis* (17), *Raphanus raphanistrum* (17), *Polygonum convolvulus* (17), *Lepidium ruderale* (17), *Stachys annua* (17), *Crepis praemorsa* (17), *Taraxacum serotinum* (17), *Hieracium umbellatum* (19), *Verbascum blattaria* (20), *Syrenia cana* (20), *Thesium linophyllum* (20), *Lychnis coronaria* (21), *Cirsium brachycephalum* (21), *Orlaya grandiflora* (21), *Viscaria vulgaris* (22), *Rumex acetosella* (22), *Digitalis grandiflora* (22), *Luzula campestris* (22), *Melampyrum cristatum* (23), *Onopordum acanthium* (23), *Camelina microcarpa* (23), *Convolvulus arvensis* (23).

of the samples

10	11	12	13	14	15	16	17	18	19	20	21	22	23
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—	—	—	—	—	+	—	—	—	—	—	—	—	—

Table 2

Life-form spectrum

	Life form, %					
	Ph	Ch	G	H	HT	Th
Species occurring in at least two samplings	17.0	4.0	5.0	49.0	16.0	9.0
Species occurrig in only one sampling	13.6	4.4	5.1	50.3	13.1	13.5

(Ph = Phanerophyte, Ch = Chamaephyte, G = Geophyte, H = Hemicryptophyte, HT = Hemitherophyte, Th = Therophyte)

life forms. Thus for example the presence of Th increases, the ratio of pH decreases. The most remarkable is, however, in both cases that, in comparison with the national 5.3% ratio, the presence of HTs is of a high percentage; here it is more than three times as high as the national, and even in case of considering the whole species list it is more than double the national ratio (MÁTHÉ, 1941).

The percentage distribution of flora elements (Table 3) appearing in the plant community (areal spectrum) shows that the percentage ratio of both the Pontic and Pontic-Mediterranean elements, as well as that of the Mediterranean elements of the specimens are highly above the national average. The Balkan-Pannonian element group is represented, in addition to *Digitalis lanata*, by *Euphorbia pannonica*, *Verbascum speciosum* and *Dianthus ponte-derae*. A Pannonian endemic, *Centaurea sadleriana* (MÁTHÉ, 1940) also appears in the species list.

On the basis of what has been discussed above it can be inferred that;

a) The occurrence of *Digitalis lanata* in the Pilis mountains of Buda can be considered spontaneous;

Table 3

Spectrum of floristic elements

	Floraelement, %											
	Eua	M(CE)	Pont	Pm	Cont	Balk—Pann	End	CE	Eu	Cp	C	Adv
Species occurring in at least two samplings	33.0	20.0	8.0	5.0	7.0	4.0	1.0	5.0	4.0	4.0	3.0	2.0
Species occurring in only one sampling	32.2	21.6	9.6	4.5	6.6	3.0	0.8	4.6	5.9	5.2	4.6	1.5

[Eua = Eurasian; M(CE) = Mediterranean—Central European; Pont = Pontic; Pm = Pontic-Mediterranean; Cont = Continental; Balk—Pann = Balkan—Pannonian; End = Endemic (Pannonian); CE = Central European; Eu = European; Cp = Circumpolar; C = Cosmopolite; Adv = Adventive]

b) it tolerates very well the anthropic effects (disturbed soil, afforestation, etc.);

c) the zone's ecological conditions are suitable for its cultivation.

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GARDENIA SUBACAULIS STAPF & HUTCH.: A PYROPHYTIC SUFFRUTEX OF THE AFRICAN SAVANNA

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Adaptive features in *Gardenia subacaulis* Stapf and Hutch. were studied on permanent plots of annually burnt tall-grass savanna near Lusaka, Zambia. *G. subacaulis* is a typical geoxylic suffrutex with perennial woody underground axes, short-lived and nearly acaulescent above-ground shoots, and fire-resistant fruits. It is able to survive recurrent burning and to sprout and blossom about three weeks after conflagration. In all probability bush-fires played an important role in the evolution of this type of geoxylic suffrutices in the African savanna.

Introduction

In tropical Africa fire very strongly influences the structure and floristic composition of savanna vegetation (COLE, 1974; EXELL and STACE, 1972; FANSHAWE, 1971; KNAPP, 1973; KOMAREK, 1972; KORNAŚ, 1978; PHILLIPS, 1974; SCHNELL, 1970–71; WEST, 1972). Fire-tender plants are eliminated, and plants which are able to survive recurrent burning are strongly favoured. These fire-resistant plants — "pyrophytes" — show a wide range of adaptive features in their structure and life phenomena. The scope of the present paper is to analyse some of such features in *Gardenia subacaulis* Stapf & Hutch. (*Rubiaceae*) — one of the most interesting ground-layer plants of the African savanna.

The author studied the effects of fire upon savanna vegetation during her one-year stay in Zambia, in 1972/73. Observations at about four weeks intervalls were carried on on two permanent plots near Lusaka, and supplemented with some data occasionally collected from various other localities. The permanent plots measured 100 m^2 each and were situated in a tall-grass savanna with *Andropogon shirensis* Hochst. ex A. Rich., *Hyperthelia dissoluta* (Nees ex Staud.) W. D. Clayton and *Hyparrhenia filipendula* (Hochst.) Stapf, burnt each year. Recording on them was started in the second half of the dry season, in late August 1972, about three weeks after conflagration. It was continued through the whole rainy season (November—March) and through the first half of the next dry season, till mid-June 1973, when a part of the area was burnt again. *G. subacaulis* grew on both study plots (abundance/dominance degree between "+" and "2" according to the BRAUN-BLANQUET's [1932] scale).

Morphological features of the plant

The genus *Gardenia* Ellis is represented in Zambia by five species (WHITE, 1962). All of them but one are small trees or erect shrubs with thick woody stems several metres tall. The only exception is *G. subacaulis,* an almost

acaulescent plant with short-lived above-ground shoots. It has, however, strong and woody underground axes (rhizomes) 1—1.5 cm in diameter in their older parts (Figs. 1, 2). The rhizomes are of sympodial growth, extensively creeping just below the soil surface or up to a dozen centimetres deeper. (They have been excavated up to the length of half a metre or so: a distance sufficient to explain the fire-resistance of the plant, but not sufficient to reveal the structure of the whole underground system.) The rhizome branches are opposite and produced most often near the rhizome apex burnt off or damaged in another way. Most of them remain short (up to 2—3 cm long) and grow directly upwards, forming the above-ground shoots, but a few are prostrate and may attain up to 10 cm in length or even more.

The above-ground parts of the shoots are very slightly lignified, and no more than 0.5—1 cm tall, with leaves densely crowded on their tops. The leaves are up to 13—16 cm long and 3—4 cm broad, subsessile and narrowly obovate, of a slightly coriaceous texture and dark green colour. The flowers are very showy (Fig. 3) but short-lasting: they open in the evening and wither the next day. The corolla consists of a slender tube up to 8 cm long and a widely

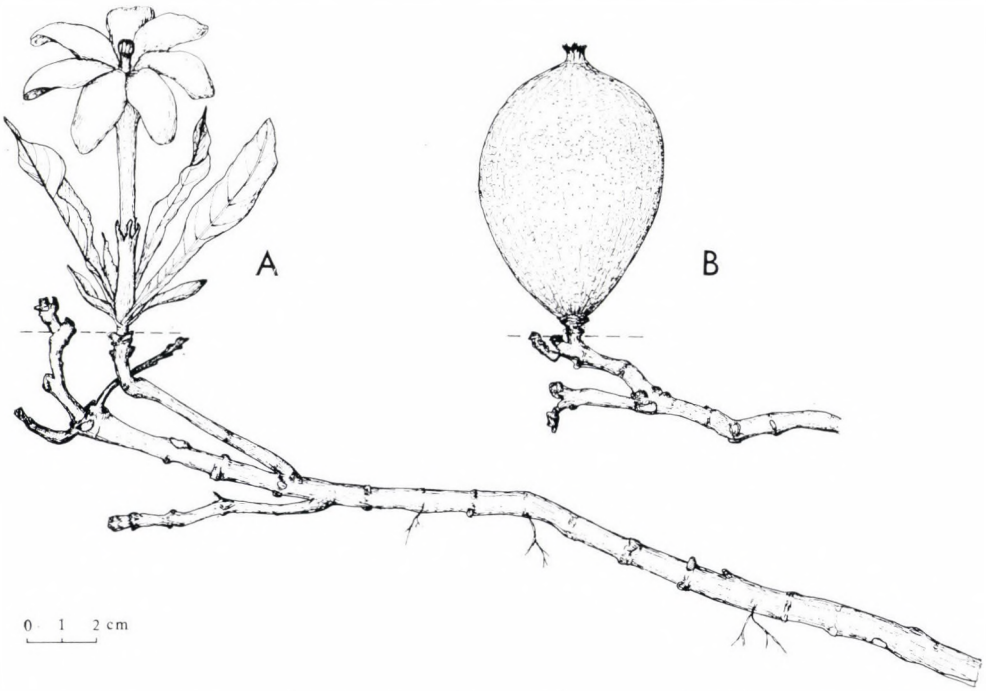

Fig. 1. Gardenia subacaulis Stapf and Hutch. in late dry season, about three weeks after bush-fire. The ground-level is indicated by broken lines. Savanna plot near Kasisi, Lusaka Distr., Zambia, 5 Sept. 1972 (J. Kornaś, Pl. Afr. 2071, KRA). A — Flowering shoot of the current season with young leaves, developed from the creeping underground axis. B — Old fruit of the previous season, which endured the bush-fire

Fig. 2. Gardenia subacaulis Stapf and Hutch. in the middle of the rainy season. Note the short above-ground shoots with fully developed leaves and young fruits, and the long underground axes. Savanna plot near Kasisi, Lusaka Distr., Zambia, 25 Jan. 1973 (J. Kornaś, Pl. Afr. 3856, KRA)

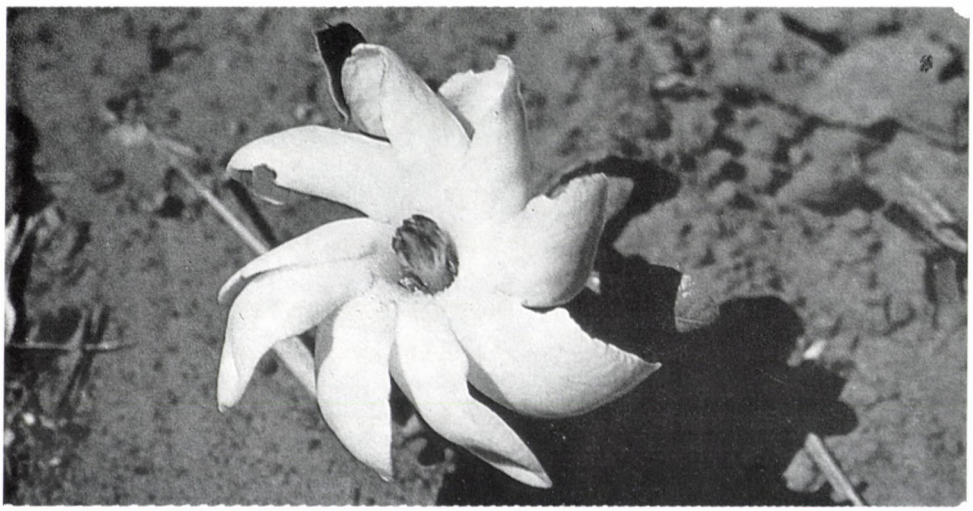

Fig. 3. Flower of *Gardenia subacaulis* Stapf and Hutch. photographed in the morning. Note the protruding stigma and the anthers inserted in the corolla throat. A young leaf appears on the right of the flower. Roadside near Kasisi, Lusaka Distr., Zambia, 11 June 1973. (Photo: Anna Medwecka-Kornaś)

Fig. 4. Old fruit of *Gardenia subacaulis* Stapf and Hutch. in recently burnt savanna plot Note the thick layer of ash on the soil surface and the charred leaves on the left of the fruit base. Near Kasisi, Lusaka Distr., Zambia, 5 Sept. 1972. (Photo: ANNA MEDWECKA-KORNAŚ)

spreading limb, 7—8 cm in diameter. Its colour is pure white at the beginning, turning yellow to the end of anthesis. The corolla throat is narrowed by the stigma protruding through its centre. The flowers are heavily scented in the evening, but only slightly smelling in the daytime. All these characteristics are those typical of the blossoms pollinated by nocturnal *Lepidoptera* (moths). FAEGRI and VAN DER PIJL (1971) and VOGEL (1954) report on a number of gardenias being pollinated in this very way. Unfortunately, no direct observation on pollinators' activity on *G. subacaulis* was possible on the study plots.

The ovary of *G. subacaulis* flower is normally situated just above the ground-level, and therefore the fruits are also epigeous in their position (Figs. 1, 4). They are indehiscent, obovoid in shape, up to 8 cm long, and have a very hard woody pericarp. The mature seeds are embedded in semi-fluid jelly-like mass.

Life form and phenology

Gardenia subacaulis very typically represents the ecological group of geoxylic suffrutices (WHITE, 1962, 1976), the most characteristic features of which are the strong perennial woody underground parts and the slightly

lignified or completely herbaceous, short-lived above-ground shoots, regularly burnt off and easily regenerated each year. The sprouting takes place soon after the bush-fire (in three weeks time on the study plots), from dormant buds situated at the base of charred above-ground shoots of the previous year, or slightly deeper on the rhizome. Putting forth of new leaves seems to be preceded by an elongation of some few of the new rhizome branches, which each year enable the plant to enlarge the area it occupies. In RAUNKIAER's (1905) system based on the position of the renovating buds, *G. subacaulis* is either a hemicryptophyte or a geophyte (with rather shallowly situated buds).

The first flowers of *G. subacaulis* appear simultaneously with the young leaves. Blossoming individuals were seen in recently burnt places at any time from June to November. Evidently, the date of production of both new leaves and flowers depends much more on the date of the preceding conflagration than on the season of the year. Phenological versatility of this kind seems to be very typical of most of the non-gramineous pyrophytes in which stimulation of sprouting and blossoming by fire has been repeatedly reported (EXELL and STACE, 1972; SCHNELL, 1970—71; WEST, 1972; WHITE, 1976).

The assimilatory organs of *G. subacaulis* reach their full development in the rainy half of the year (in January on both study plots) (Fig. 2). The plants, however, retain their foliage at least for the first months of the dry season (as seen in May on the study plots). In some herbarium sheets charred leaves of the previous rainy season were found, obviously destroyed by fire when still in the living state (Fig. 4). This proves that the plant most probably lacks an inherent rythm of leaf fall and that defoliation is imposed mainly by the regime of recurrent bush-fires.

When passing through the savanna, fire normally consumes all the above-ground parts of *G. subacaulis* except for the ripe fruits which are efficiently protected by their hard woody pericarp, and therefore usually remain undamaged, with at most a few small and slightly charred burning marks. The numerous egg-shaped fruits of *G. subacaulis* 'laid' on the ash of the barren ground of the burnt savanna present a very strange view (Fig. 4). In the rainy season their basal parts decay and the seeds are eventually released.

Evolutionary problems

Geoxylic suffrutices are known chiefly from the southern tropical Africa, where they often play an essential role in fire-affected plant communities. This was also true of the study plots where eight species of suffrutices occurred: *Annona stenophylla* Engl. et Diels subsp. *nana* (Exell) Robson (*Annon.*),

Clerodendron pusillum Gürke (*Verben.*), *Cussonia corbisieri* De Wild. (*Aral.*), *Gardenia subacaulis* Stapf et Hutch. (*Rub.*), *Lannaea edulis* (Sond.) Engl. (*Anacard.*), *Psychotria* cfr. *spithamea* S. Moore (*Rub.*), *Pygmaeothamnus zeyheri* (Sond.) Robyns (*Rub.*), *Syzygium guineense* (Willd.) DC. subsp. *huillense* (Hiern.) F. White (*Myrt.*).

Geoxylic suffrutices apparently represent a case of convergent evolution caused by a common driving force which is, however, difficult to be sorted out. Savanna plants grow under pressure of various stress factors all of which may have very strong selective effects: burning, overgrazing, seasonal drought, excessive heat, and soil poverty. WHITE (1976) is of the opinion that nutrient defficiencies played a decisive role in promoting the evolution of geoxylic suffrutices. Alternative explanations are those assuming that the key factor was either water stress or fire impact. The last supposition, put forward e.g. by EXELL and STACE (1972), seems to be the most plausible. It appears to be supported by the following observations. A number of 'normal' trees of dry forests and savanna woodlands may persist in accidentally burnt areas and produce herbaceous offsets from the woody underground parts. When burning is frequently repeated these offsets closely resemble the growth form of suffrutices. This indicates the way in which the hereditary fixed life form of a true geoxylic suffrutex may have developed. In fact, many geoxylic suffrutices have closely related taxa among trees growing in places normally not subject to fire, or burnt only very rarely. In the case of *G. subacaulis* such a closely related tree species is *G. jovis-tonantis* (Welw.) Hiern., which grows in woodlands on termite mounds (WHITE, 1962) and seems to approach what very likely has been the tree-like ancestor of *G. subacaulis*.

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CHEMISCHER ZUSTAND DER ATMOSPHÄRE IN INDUSTRIEGEBIETEN UND DIE NATÜRLICHE VEGETATION

Von

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(Eingegangen: 15. Juni, 1979)

Unter dem menschlichen Einfluß ändert sich das ganze Komplex von atmosphärischen Umweltbedingungen, das für die Kartierung der potentiellen natürlichen Vegetation als irrelevant betrachtet wird. Die Luftverunreinigung im Bereich der Industriegebiete erreicht jedoch schon eine solche Stufe, daß nicht nur die Entwicklung, sondern auch die Erhaltung der natürlichen Vegetation verhindert wird. Die Kartierung der potentiellen natürlichen Vegetation in solchen Gebieten bietet in vielen Fällen schon eine ungenügende Unterlage für die Einführung von natürlichen Vegetationselementen bei der Vegetationsanbauplanung. Aus diesem Grund wurde die Konstruktion einer hypothetischen Vegetation vorgeschlagen, die nicht nur die irreversiblen, vom Menschen erzeugten Standortsbedingungen, sondern auch die vom Menschen bedingten reversiblen Umweltbedingungen (ausgenommen aller Eingriffe in die Vegetation direkt) widerspiegeln würde. Diese höchstentwickelte, klimaxartige Pflanzendecke wird als die den anthropogenen Umwelt gemäße natürliche Vegetation (oder natürliche Vegetation der Anthropoökotope) bezeichnet.

Schon in den ersten ökologischen Studien wurden enge Beziehungen zwischen der natürlichen Vegetation und dem physikalischen Zustand der Atmosphäre, der in seinem langjährigen Regime als Klima bezeichnet wird, betont. Die relativ stabilen chemischen Eigenschaften sind dagegen als indifferent betrachtet worden, da sie auf der Erdoberfläche einheitlich verteilt sind. Die lebenden Organismen sind auf eine bestimmte chemische Zusammensetzung der Atmosphäre eng adaptiert und bei ihrer Änderung reagieren sie meistens durch negative Erscheinungen. Zur Änderung der chemischen Zusammensetzung der Atmosphäre kommt es in erheblichem Maße erst in den Nachkriegsjahren. Wenn es sich auch vom quantitativen Gesichtspunkt aus nur um ziemlich geringe Änderungen handelt, sind es im allgemeinen qualitativ doch sehr wirksame Stoffe mit einem starken Einfluß auf lebende Organismen. Auch die Räume der Wirkung sind viel größer als die eigenen Industrieareale. Es kommt langsam zu einer globalen Luftverunreinigung, die selbstverständlich in verschiedenen Gebieten verschiedene Intensität aufweist. Die gasartige und korpuskulare Luftverunreinigung wird auch durch bestimmte physikalische Zustände in den niedrigen Schichten der Atmosphäre erhöht oder erniedrigt und umgekehrt durch den chemischen Zustand der Atmosphäre können biologisch wirksame physikalische Eigenschaften der Atmosphäre wie

Qualität und Intensität der Sonnenstrahlung, Luftfeuchtigkeit, Niederschläge usw. beeinflußt werden. So ändert sich direkt das ganze Komplex von atmosphärischen Umweltbedingungen, sowie indirekt die Bodeneigenschaften durch Transport von Chemikalien aus der Luft in den Boden.

Die wichtigsten biologisch wirksamen Stoffe, die die industrielle und andere menschliche Tätigkeit in die Atmosphäre hinausschickt, sind Schwefel- und Stickstoffoxide, Arsen, Fluor, Schwermetalle, aber auch organische Moleküle und radioaktive Elemente. Die Vegetation reagiert bei gewisser Konzentration selektiv, durch verminderte Vitalität, Empfindlichkeit gegen Parasiten, später durch nekrotische Erscheinungen, Absterben von empfindlichen Arten, deren Platz widerstandsfähige Pflanzen einnehmen. Die Luftverunreinigung großer Räume erreicht heute schon eine solche Stufe, daß sie die quantitative und qualitative Zusammensetzung der realen Vegetation markant beeinflußt. Am empfindlichsten reagieren viele Flechtenarten, aber auch höhere Pflanzen, besonders Koniferen mit wintergrünen Blättern.

Da nach dem Aufhören der menschlichen Tätigkeit die Luftverunreinigung in sehr kurzer Zeit durch Luftmassenausgleich abklingen würde, rechnet man bei der Konstruktion der potentiellen natürlichen Vegetation im Sinne von Tüxen (1956) nicht mit diesen aktualen Standortsfaktoren (Tüxen, 1974, in litt.: Immissionen einer Fabrik sind nicht anders zu bewerten als Beweidung, Mahd, Pflügen usw., d. h. menschliche Einflüsse, die für den Augenblick die potentiell natürliche Vegetation fernhalten, ohne den Standort irreversibel zu ändern). In Immissionsgebieten stellt dann eine Karte der potentiellen natürlichen Vegetation Vegetationseinheiten dar, die heute, und auch in der baldigen Zukunft, überhaupt nicht existieren können. Als Beispiele sind Verhältnisse in einigen Immissionsgebieten der Tschechischen Länder anzuführen: Im Krušné hory-Gebirge (Erzgebirge) kommen in der hochmontanen Stufe Klimax-Fichtenwälder und vernäßte Fichtenwälder als natürliche Vegetation vor; sie werden ebenfalls als potentielle natürliche Vegetation an abgeforsteten Standorten konstruiert. Der heutige chemische Zustand der Atmosphäre in großen Teilen dieses Gebietes verhindert jedoch der Fichte auch in eigenen Klimax-Fichtenwäldern aufzutreten. In naturnahen Klimaxwäldern stirbt die Fichte komplett aus und wird durch Rest-Holzarten wie *Sorbus aucuparia*, aber besonders durch nitrophile Pionierarten ersetzt.

Eine ähnliche Situation entsteht großräumig auch in Lagen der Eichen-Tannenwälder Mitteleuropas. Die Tanne als eine auf SO_2-Gehalt in der Luft sehr empfindliche Holzart fällt aus naturnahen Gesellschaften ohne Reste heraus und wird durch andere anspruchslose Laubholzarten ersetzt. Dadurch ändert sich die naturnahe Phytozönose eines Mischwaldes in eine Laubwaldgesellschaft. Im Železné hory-Gebirge ist das z. B. eine Änderung des *Abieto-Quercetum* ins *Luzulo-Quercetum*, wobei nicht nur die Tanne, sondern auch an diese gebundene Trennarten des *Abieto-Quercetum* erlöschen.

Auch wenn man diese Erscheinungen als reversible betrachten kann, sind diese sekundären menschlichen Eingriffe so tiefgreifend und langfristig, andererseits auch zwecklos (im Vergleich mit zielbewußter Tätigkeit wie Mahd, Weide, Pflügen usw.), sogar schädlich, so daß sie eine spezielle Bewertung verdienen. Es besteht Gefahr, daß durch das Industrieklima Areal von Pflanzengesellschaften und Sippen in erheblichem Maße geändert weren. Aus den angeführten Beispielen folgt, daß unter heutigen Standortsverhältnissen auch die heutige naturnahe Vegetation einer Restrukturalisierung unterliegen vermag, bei der es auch zur Änderung von Dauer- und Klimaxgesellschaften gelangt. Die Karten der potentiellen natürlichen Vegetation verlieren für Gebiete mit einem geänderten Industrieklima ihren Aussagewert als Unterlage für den Anbau der standortsgemäßen Vegetation. Die natürliche, hochentwickelte (klimaxartige) Vegetation stellt jedoch das stabilste Element der Pflanzendecke einer Landschaft dar. Eine solche natürliche Vegetation entwickelt sich nicht nur unter Naturverhältnissen, sondern auch unter menschlich geänderten Bedingungen, falls direkte und undirekte Eingriffe in die Vegetation aufhören. Die vom Menschen erzeugten Umweltbedingungen sind in zwei Kategorien einzuteilen:

1, Irreversibel geänderte oder künstlich erzeugte Dauerstandorte. Zu diesen gehören Lagen mit geändertem Wasserregime wie regulierte Alluvionen, entwässerte Böden, aber auch künstliche Wasserbecken, weiter Flächen mit künstlich geändertem Bodenzustand wie ausgedüngte Äcker, Ablagerungsplätze usw. Solche Standortsbedingungen spiegelt die potentielle natürliche Vegetation wider.

2. Reversibel, zeitgemäß geänderte Umweltbedingungen, verursacht durch Luftverunreinigung, Lufttrockenheit und -erwärmung nach Abbau der Pflanzendecke, besonders in Großstadtarealen (Wüstenklima der Großstädte) usw. Standortsfaktoren dieser Kategorie wirken jedoch langdauernd, sind durch menschliche Tätigkeit kontrolliert, können auch vorgesehen oder geplant werden. Im Gegenteil zu den unter Punkt 1. angeführten Standortsfaktoren werden diese bei der Konstruktion der potentiellen natürlichen Vegetation vernachlässigt.

Da der Einfluß der unter Punkt 2. angeführten Faktoren großräumig und langfristig zur Geltung kommt, scheint es zweckmässig zu sein, eine hypothetische, höchstentwickelte (klimaxartige) natürliche Vegetation zu konstruieren, die nicht nur die irreversiblen, vom Menschen erzeugten Standortsbedingungen (wie die potentielle natürliche Vegetation), sondern auch die langfristig wirkenden reversiblen Umweltbedingungen wie Luftverunreinigung usw. widerspiegeln würde. Bei der Konstruktion dieser der anthropogenen Umwelt gemäßen natürlichen Vegetation sollten die gleichen Prinzipien wie bei der Konstruktion der natürlichen potentiellen Vegetation angewandt werden (Tüxen, 1956; Trautmann, 1966; Neuhäusl, 1975). Zum Unterschied

von der potentiellen natürlichen Vegetation wird die der anthropogenen Umwelt gemäße natürliche Vegetation (natürliche Vegetation von Anthropoökotopen) alle menschlich erzeugten Umweltbedingungen (reversible sowie irreversible) mit Ausnahme direkter und undirekter Eingriffe in die Vegetation widerspiegeln. Da sich diese Umweltbedingungen ändern, muß für die Konstruktion ein bestimmter Zeittermin angegeben werden. Vom praktischen Gesichtspunkt aus ist von größter Bedeutung die natürliche Vegetation, die den heutigen Verhältnissen entspricht. Für die Gebietsplanung kann jedoch auch die Konstruktion der den zukünftigen (für eine bestimmte Zeitperiode geplanten) Umweltverhältnissen entsprechenden natürlichen Vegetation eine geeignete Unterlage bieten. Da die natürliche Vegetation von Anthropoökotopen in vielen Fällen durch heute noch unbekannte Pflanzenvergesellschaftungen gebildet werden kann, muß man bei ihrer Kartierung mit hypothetischen Gesellschaften, die man nur zu Vegetationseinheiten höherer Rangstufen zuordnen kann, arbeiten. Die Resultate der Vegetationsforschung in Anthropoökotopen ermöglichen uns schon heute die wichtigsten strukturellen Merkmale wie die Schichtenfolge, die Artenzusammensetzung der Baumschicht und die soziologische Stellung im Rahmen von mindestens höheren Vegetationseinheiten zu beurteilen. Über die Methoden der Kartierung der der anthropogenen Umwelt gemäßen natürlichen Vegetation wird an einer anderen Stelle berichtet.

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THE EPIPHYTIC BIOMASS AND ITS EFFECT ON THE WATER BALANCE OF TWO RAIN FOREST TYPES IN THE ULUGURU MOUNTAINS (TANZANIA, EAST AFRICA)

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The epiphytic biomass of a submontane rain forest was estimated to be 2130 kg/ha dry matter, while its rain intercepting capacity around 15 000 l/ha. On the other hand, the epiphytic biomass of a mossy elfin forest at 2120 m altitude is near 14 000 kg/ha and its intercepting capacity is near 50 000 l/ha during one rainfall. The aerial humus accumulation is much higher (ca 4700 kg/ha) in the elfin forest than in the submontane rain forest (ca 375 kg/ha). There is a positive correlation between the amount of surplus rainfall (the rainfall above 100 mm/month) and that of the biomass of epiphytic vegetation in rain forest climates.

Introduction

The African epiphytic vegetation was first studied by Busse (1905), who studied the epiphyllous communities in the Cameroon. Later Oye (1924) and Lebrun (1937) dealt with the macroepiphytes of Congo basin. Klement (1962) investigated a few lichen communities in Tanganyika, while Sanford (1968, 1969) studied the distribution and ecology of epiphytic orchids in Nigeria. A milestone was in the African epiphytic studies the modern monography of the macroepiphytic vegetation of Loma Mts., Liberia by Johansson (1974), who investigated the composition of epiphytic communities, their relation to host trees, their succession, reproduction and their environmental conditions in general. Serusieux (1975) studied the epiphyllous lichen vegetation of Central Africa, while Pócs (1978) analysed in detail the epiphyllous bryophyte communities of East Africa. Harrington (1967) and Olarinmoye (1974, 1975) dealt with the growth ecology and with the succession of epiphyllous liverworts in West Africa. Pócs published the first data on the biomass, humus accumulation and water interception of epiphytic vegetation in Africa in a short paper (Pócs, 1976), without adequate documentation and interpretation of the data obtained. The aim of the present paper is to discuss in details the epiphytic biomass and its effects on the water balance of a submontane rain forest and of an upper montane mossy elfin forest community in East Africa, and to draw some general conclusions about the relation between epiphytic vegetation and the water factor in tropical forest ecosystems.

The epiphytes in the northern temperate region usually do not play an important rôle in the ecosystem. Even in the oceanic part of Europe Schnock (1972) weighed only 355 kg epiphytic biomass per hectar in oak forests, while Simon (1974) estimated the epiphytic biomass of a Hungarian oak forest under continental climatic conditions only to be 41 kg/ha. On the other hand, terrestrial mosses and lichens are important in the soil fixation and humus accumulation of continental steppe communities (Simon, 1975; Simon and Láng, 1972; Láng, 1974; Orbán, 1977), where their biomass can be as much as 4000 kg/ha.

Methods

While the methodology of tropical forest ecosystem research is more or less known and adopted by many authors (cf. NEWBOULD, 1967; RODIN—BAZILEVICH, 1967; KIRA, OGAWA, YODA and OGINO, 1967; MÜLLER, 1967), no one has really dealt with the epiphytic components. Therefore the author had to elaborate his own methods. The case of elfin forest was simple, because all strata were within reach, if one climbed up in the dense canopy of the 3—4 m high, umbrella shaped trees. Squares had to be cut out in the sampling area from all layers, which were placed in plastic bags and taken down to the laboratory for selecting into components.

The more complicated case was to estimate the biomass of the epiphytic communities in the submontane rain forest. The working hypothesis was to obtain results by selecting available (e.g. freshly cut) sample trees on which all types of epiphytes occuring in the area could be collected and to multiply their number or the surface covered by them accordingly. I tried to approach the results obtained to reality, using as many sample trees and analysing as many kinds of epiphyte types, as I could, by cutting and climbing trees, by counting the number of larger nests of epiphytes with binoculars, or counting the tree stems of the same size and covered by microepiphytes the same way.

The samples were weighed first on the plot, after all samples, taken in plastic bags to the laboratory, were weighed again. In some cases this was not an easy task, a bigger *Asplenium nidus* nest being often heavier than 40 kg. In the case of the canopy, representative branches were analysed, their epiphytes carefully collected and the data multiplied by a factor counted from an approximate coverage percent. In case of the larger nest epiphytes at least five different specimens were weighed and their average size was multiplied by a factor obtained by counting them in a hectar area. The foliage of phorophyte trees was estimated the same way. Of course the data obtained this way are only approximate.

The epiphytes carried into the laboratory were selected to leaves, stems, alive and dead root systems, litter and humus accumulated in and among the epiphytes. The fresh weight of turgescent but not wet plants proved to be quite stable and important from the point of view of intercepting capacity. The fresh plants were moistened maximally then left for half hour time on a wire net till the not absorbed water was able to trickle down. After this modelled rain they were weighed again and their interception capacity was obtained, and counted later related to the dry weight of epiphytes. Cushion forming microepiphytes (mosses, liverworts and small ferns, orchids) were left in their original form during this procedure. Finally, all plants were dried at 80 °C temperature in an oven, and their stabilized dry weight obtained. The values of dry and fresh matter and interception capacity, applying the above mentioned factors, were counted for one hectar area. From the thousands of data only a few samples will be shown, illustrating the different epiphyte types by diagrams. These diagrams show fresh and dry matter and the interception capacity of the different fractions of epiphytes and the humus assimilated by them. Their behaviour with respect to water absorption and humus accumulation is quite different, and the importance of different plant parts varies according to epiphyte types, as shown below.

Analysis of two rain forest types

I. *Submontane rain forest* (Figs. 2—4)

The sample area lies in the northern part of Uluguru Mountains, SW of Morogoro town, in the Mwere valley, at 1415 m altitude. The valley is open to the NE direction. A very humid type of rain forest stands on its flat bottom

and gentle slopes. The stand is about 40 m high, the canopy is divided into 2—3 storeys. The forest type has been described by Pócs (1974: 121, or more in details in 1976: 486). It is evergreen, rich in epiphytic ferns, especially in nest epiphytes. The lower storey of canopy is often formed by tree ferns of

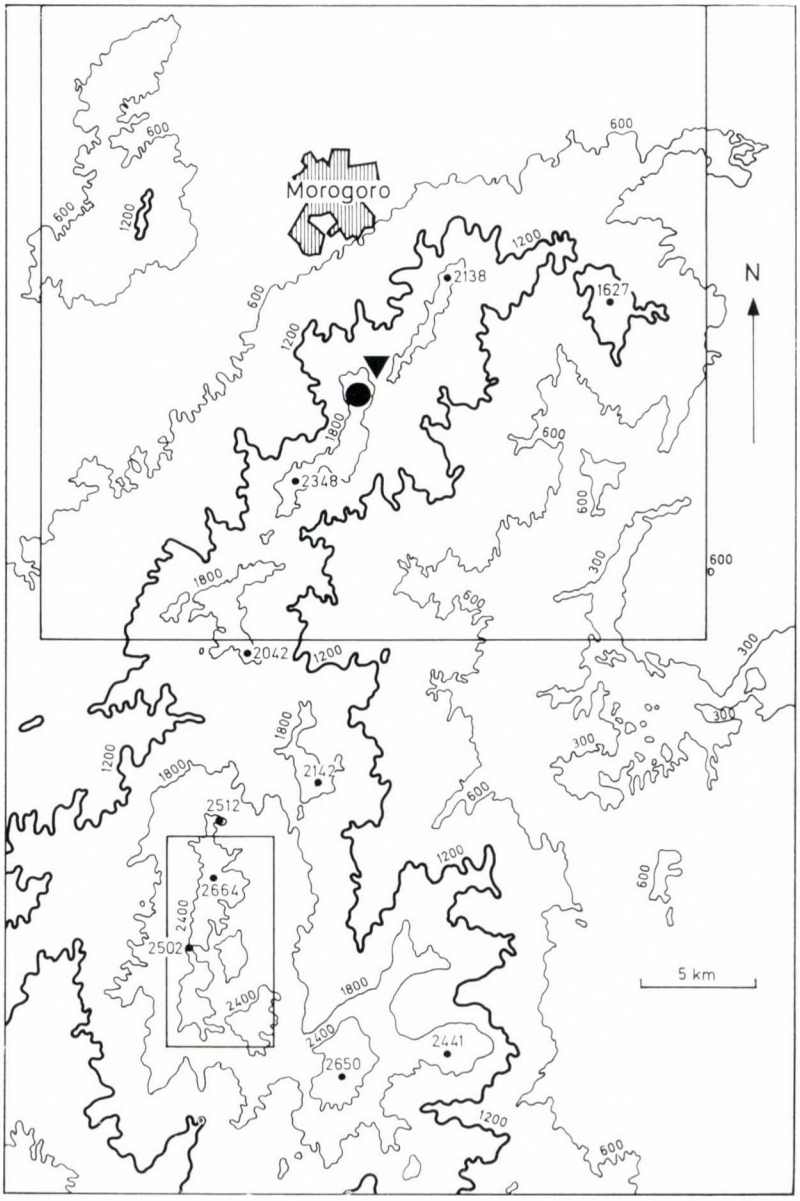

Fig. 1. The location of sample plots in the Uluguru Mts. Triangle: submontane rain forest in the Mwere valley. Full circle: mossy elfin forest on the Bondwa top

Fig. 2. The edge of the investigated submontane rain forest area in the Mwere valley

Fig. 3. Interior of the submontane rain forest. On the tall tree fern stem hanging epiphytic *Lycopodiaceae*

Fig. 4. Tree ferns in the submontane rain forest of Mwere valley

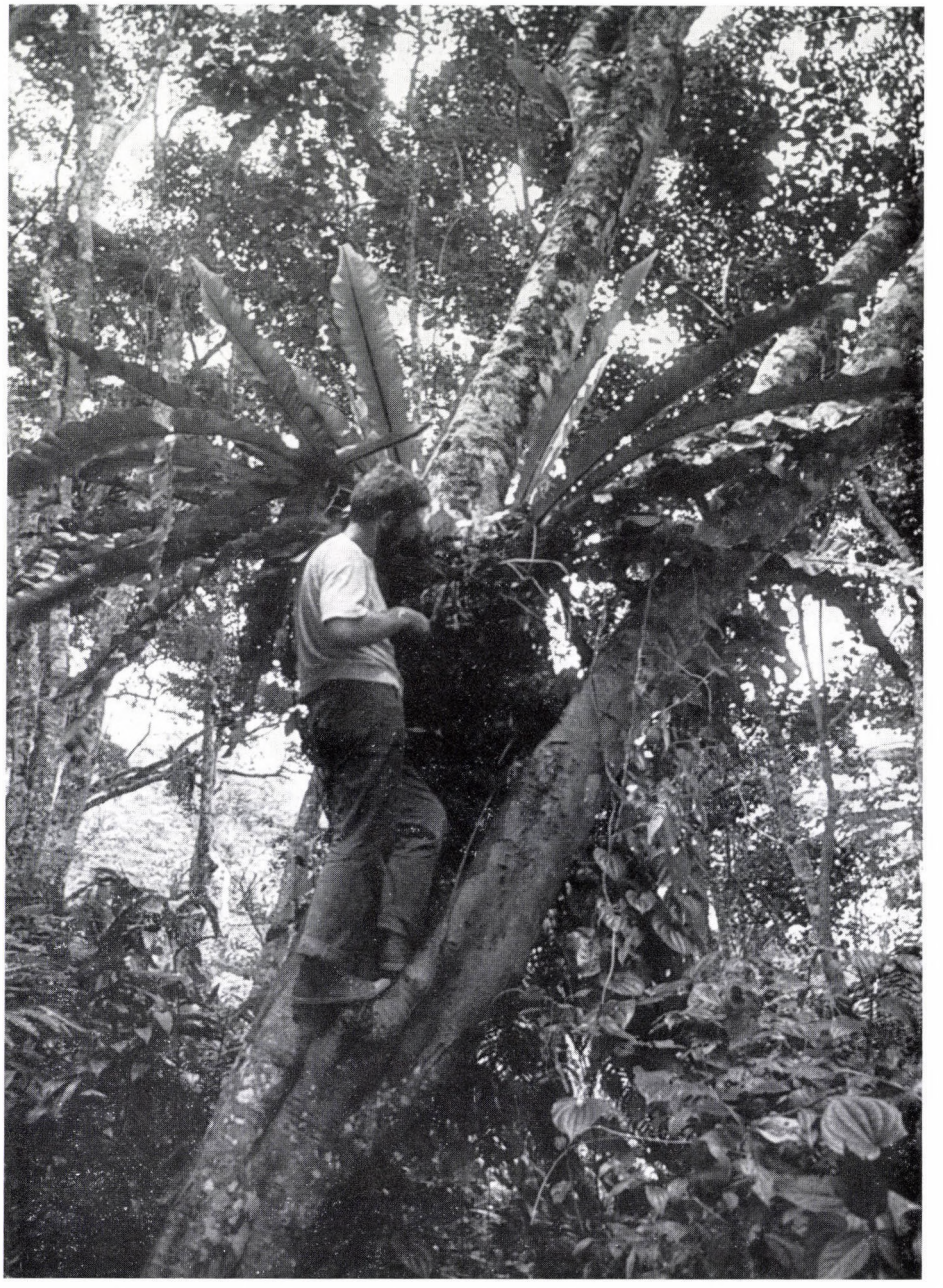

Fig. 5. The removal of *Asplenium nidus* epiphyte nest from 5 m height. The same nest is analysed on Table 2

6—10 m height (see fig. 4). The understorey is very rich in ferns, more than 40 species occur in the sample area.

Characteristic epiphytes of the forest:

a) *Asplenium nidus* L. (Figs. 5—8)

Nest forming macroepiphyte, occuring in lowland and in submontane rain forests on tree stems, on large branches or often in the fork of branching. This fern is widely distributed in tropical Asia and Oceania, but in Africa it occurs only in Madagascar, Mascarenes and in the eastern, crystalline mountains of Tanzania. According to WENT (1940: 40) and to the related taxonomic literature *Asplenium nidus* is a herbaceous plant with erect rhizome. I have found many similarities between *A. n.* and the pachycaul tree ferns. The older specimens of *Asplenium nidus* have half-woody, vertical stem surrounded by nest forming, decaying petioles, roots and humus. The only difference is, that the stem of *Asplenium nidus*, below its living part, continues into a decaying one — otherwise it should be classified easily into CORNER's model of mono axial trees, similarly to many *Cyathea* species (cf. HALLÉ—OLDEMAN—TOMLIN

Fig. 6. The longitudinal section of the nest pictured on Fig. 5. The visible length of the tape-measure is 1 m. The living part of the vertical fern stem is conspicuous by its whitish color

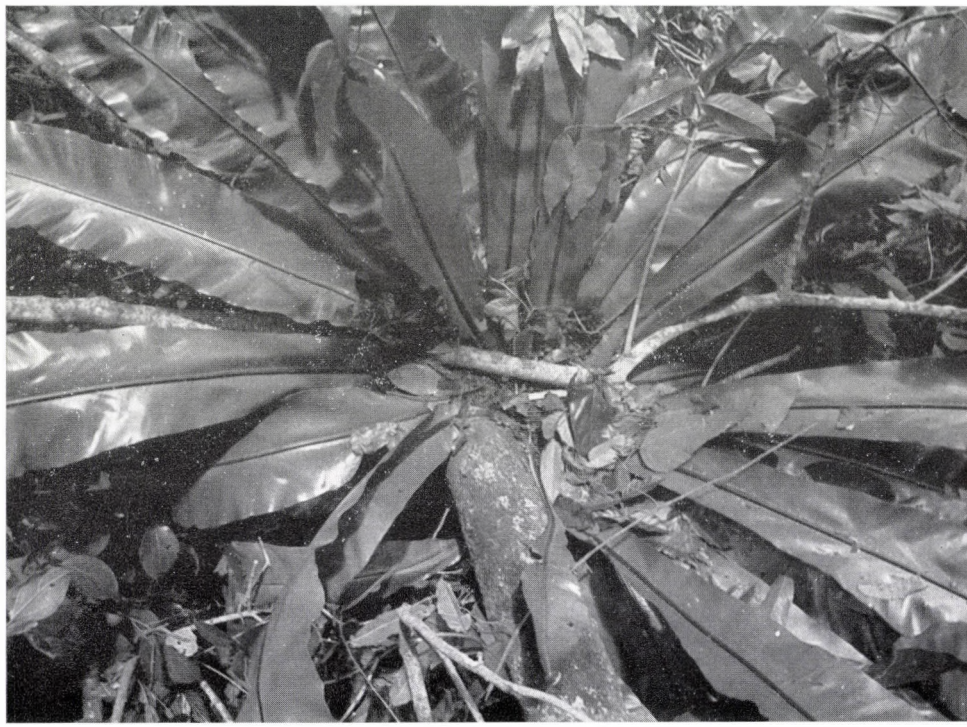

Fig. 7. Fallen litter and detritus accumulation in an *Asplenium nidus* nest. The litter of previous years among the older leaf bases is already transformed into nest-humus, interwoven by living and dead roots (see Fig. 6)

SON, 1978: 84, 109—118). The vertical, half woody stem surrounded by decaying leaves and roots reaches in some cases the length of 1.5—2 metres (see Fig. 5 and 6). In young specimens (see nos. 1. and 2. below in Table 1) usually the whole stem is alive. The data of a few average specimens are shown in the Tables 1 and 2. As it can be seen, the maximum size of leaves correlates better

Table 1

Records on nesting Asplenium nidus specimens

	Number of living leaves	Fresh matter of the whole nest, in kg	Living + dead stem length in cm
1.	26	3.5	22 + 00
2.	23	11.0	64 + 00
3.	56	48.0	45 + 23
4.	31	10.5	39 + 26
5.	28	4.3	32 + 18

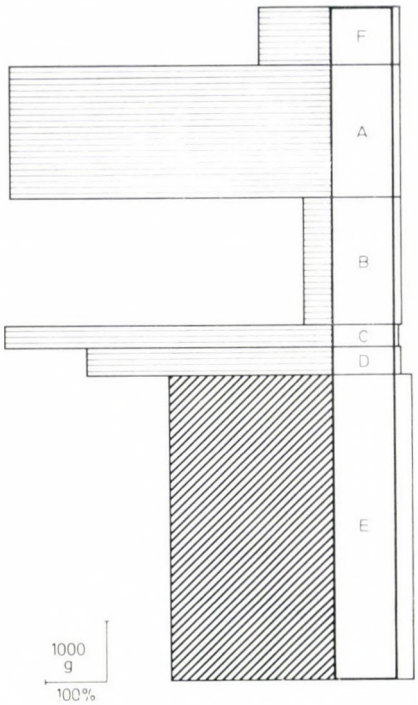

Fig. 8. Diagram of the *Asplenium nidus* nest analysed in Table 2. The vertical axe expresses the dry matter, in g the horizontal one expresses the fresh matter in the percentage of the dry matter represented by the white fields. On the right the water absorption is expressed from the laboratory air. The letter symbols are the same as in Table 2

to the age of specimens expressed in the stem length, than with the number of leaves. The weight of nests does not always correlate to their age. The largest leaves develop on old, heavy specimens, e.g. in the case of no. 3. in Table 1 their length reaches 225 cm.

From the data shown in Table 2 and on the Fig. 8 it is clear, that the water content of the different living and dead fractions varies highly. It is also clear, that in this case of an old nest epiphyte the greatest amount of "biomass" is represented by the accumulated humus, which joins the nutrient cycle of the host forest only after the death of the epiphyte. The amount of aerial humus in epiphyte nests (see also page 156) in tropical ecosystems could represent an amount comparable to the soil humus (cf. KLINGE, 1963).

By this example the interception capacity (which in *Asplenium nidus* is very similar to that of *Macrosorium punctatum*, see page 153) was not analysed. Instead the water absorption capacity of the dry material from the air under laboratory conditions was measured. This indicated a high absorption ability of the decomposing nest roots and nest humus, which surely helps

Table 2

Detailed data of an average Asplenium nidus specimen

	Fresh matter in g	Dry matter in g	Water content % related to dry matter	Water absorbed from laboratory air during one day by 28 °C and 60 – 90% relative air humidity*
A Living leaves (43 leaves, 180 cm max. length)	13,494	2,159	525	13
B Hanging, dead leaves	2,930	2,069	42	14
C Living stem	2,480	391	534	13
D Living, nesting root system	2,470	489	405	14
E Decomposing roots + humus	18,600	5,103	265	23
F Litter and fallen detritus	2,530	953	62	13
Total of the whole nest	42,504	11,164	281	* Expressed in % of the dry matter

Asplenium nidus to survive during dry periods, absorbing air humidity, mist and dew. Among tropical "room conditions" the dried nest humus was able to absorb from air an amount of water corresponding to about 10% of the former water content of living leaves!

b) *Microsorium punctatum* (L.) Copel. (Fig. 9)

In the nest humus of this epiphyte of lowland and submontane forests very often also other macroepiphytes establish themselves and form a characteristic nest community described from West Africa by JOHANSSON (1974: 81—83). Their composition is not all stable, although several species are more constant and show preference to this humus rich locality, as *Asplenium pseudohorridum* and *Vittaria zosterifolia* in the East Usambara Mts., *Asplenium dregeanum, A. mannii* and *Davallia chaerophylloides* in the Uluguru Mts. The studied *Microsorium* nest originated from the sample plot, collarlike surrounding the stem of a 10 m tall *Cyathea manniana* tree fern at its 6 m altitude, where the stem had only 5.5 cm diameter.

From the data shown in Table 3 and on Fig. 9, the very different hydrature conditions of the community components, as well as the great importance of the accumulated humus in the water interception, are obvious. This high interception ability of nest humus is surpassed only by those of the actively water absorbing, feltlike nestroot system. These nestroots are important for the nest fern, but, because of their limited biomass, less important for the whole of the ecosystem.

Table 3

Detailed data of the Macrosorium nest synusium

	Fresh matter, g	Dry matter, g	Water content in dry m.%	Interception capacity in dry matter %
AA Living *Microsorium* leaves (43 leaves, 80—120 cm length)	3,769	739	412	
CA Living *Microsorium* rhizomes	3,850	1,501	156	116
DA Living, water absorbing nest roots	2,608	885	195	335
EA Fine humus accumulated in the nest	7,502	3,173	136	272
AB *Asplenium dregeanum* living in the nest	6.5	1.6	180	
AC *Asplenium mannii* living in the nest	6.8	1.2	440	
AD Living leaves of *Procris crenata*, succulent epiphyte in the nest	54.6	7.9	588	
CD Living stem of *Procris crenata*	919.8	77.5	1,087	
F Litter and other detritus fallen in the nest	906.4	404.3	124	130
Total of the whole nest	19,623	6,790	189	204.15% (13,859.68 g)

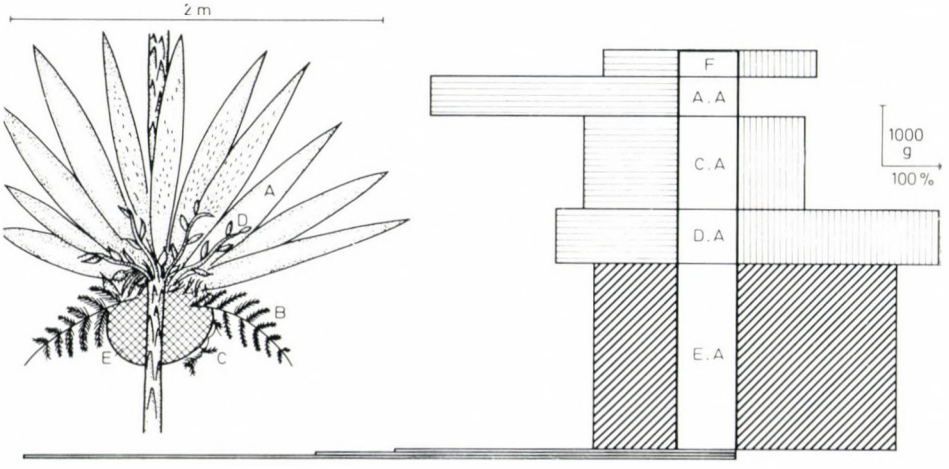

Fig. 9. Biomass and water interception diagram of the *Microsorium punctatum* nest analysed in Table 3. The height of white fields expresses the dry matter in g, the horizontal extent of stripped fields shows to the left the fresh matter and to the right the interception capacity, in dry matter %. The letter symbols are the same, as in Table 3

c) Nest of *Asplenium dregeanum* Kunze (Fig. 10)

Asplenium dregeanum forms nests alone too, by itself, without adjoining to other species. Its nests are common on *Cyathea* stems, but much smaller than those of *Microsorium punctatum*. Data of an average *Asplenium dregeanum* nest are shown on Table 4 and on Fig. 10. These data confirm the importance of nesting roots and aerial humus in the water absorption and interception.

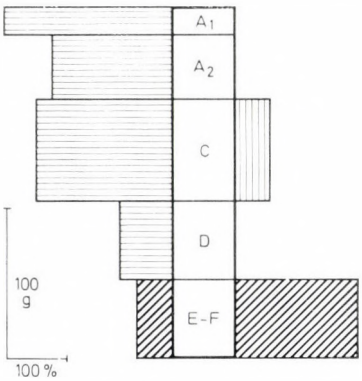

Fig. 10. Biomass and water interception diagram of an *Asplenium dregeanum* nest, described in Table 4

Table 4

Data of an Asplenium dregeanum nest

		Fresh matter, g	Dry matter, g	Water content in dry m.%	Interception capacity in dry matter %
A_1	Assimilating leaf pinnae (10 great l.)	57.81	15.50	273	
A_2	Petioles	119.76	40.15	198	
C	Fleshy rhizomes	209.42	64.54	224	64
D	Nestroots	96.84	51.99	86	304
E	Humus and detritus in the nest	99.01	59.99	65	208
	Total of the whole nest	582.84	232.17	151	

d) *Arthropteris orientalis* (J. F. Gmel.) Posthumus (Fig. 11)

In the sample plot it occurs often together with *Arthropteris monocarpa* (Cordem.) C. Chr., as a creeping epiphyte, on trees and on tree fern stems. As it is figured on Table 5 and on Fig. 11, a very large proportion of its fresh and dry matter is built up by the water absorbing, creeping rhizome and accessory

Fig. 11. Biomass and water interception diagram of *Arthropteris orientalis* (see Table 5)

Table 5

Data of Arthropteris orientalis, creeping epiphytic fern

	Fresh matter, g	Dry matter, g	Water content in dry matter %	Interception capacity in dry matter %
A Leaves	4.43	1.14	288	
C + D Rhizomes and roots	61.46	19.85	210	155

roots, but their intercepting ability is much less, than that of the nest epiphytes.

e) *Corticolous microepiphytes* (Fig. 12)

Microepiphytes, mostly mosses, liverworts and filmy ferns, cover the trunks in the sample area at least up to 4 m height, often higher, forming an about 10 mm thick fur. Higher up they give place to scattered, less hygrophilous lichen communities, while on the branch system more heliophilous mosses and lichens take place, which are at the same time hygrophilous, receiving and intercepting more of the rainfall. The example below was taken from the trunk of a tree of 40 cm diameter, from the height of 110—120 cm. The girth at the lower edge of the sample was 126 cm, while at the upper edge 121 cm. The whole area of 12 350 cm^2 was covered evenly by ***Leucoloma*** sp. at a rate of 60% of the whole surface. Among the mosses filmy ferns were

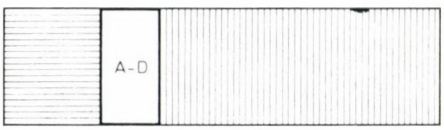

Fig. 12. The biomass and water interception of corticolous microepiphytes in the submontane rain forest area (see Table 6)

Table 6

Data of the corticolous microepiphyte synusium

	Fresh matter, g	Dry matter, g	Water content in dry matter %	Interception capacity %
The whole corticolous microepiphyte synusium	199.7	78.18	155	471

creeping, covering about 15% of the whole area. The data of the above synusium are shown on the Table 6. The microepiphyte cover was proved to be the most succesful interceptor, due probably to the highly increased surface of small leaves and to the capillary water retained among the tiny shoots. This is why the water interception in mossy forests is much higher, than in any other vegetation types in the tropics (see also pages 162).

The epiphyte biomass—water interception model of the submontane rain forest plot

(see Table 7 and Figs. 13—14)

In the knowledge, that any model of this kind, obtained by extrapolation of data, is artificial to an extent, and has only approximate accuracy, I tried to compose a model using the above and many other data, multiplying

Table 7

The epiphyte biomass—water interception model of the submontane rain forest plot

	Fresh matter, kg	Dry matter, kg	Water content in dry matter %	Interception capacity	
				in dry m.%	in l/ha
I. Phorophyte leaves	49,146	30,000	63.8	45.4	13,641
II. Ramicolous microepiphytes in canopy	3,075	1,695	81.4	508.0	13,644
III. Microepiphytes on tree trunks	200	78	156.4	434.0	339
IV. Leaves of the macroepiphytes on tree trunks	183	23	695.6	45.4	73
V. Root system of macroepiphytes on tree trunks	139	55	152.7	192.2	341
VI. Leaves of nest epiphytes	195	34	473.5	45.4	15
VII. Living root system of nest epiphytes	158	62	154.8	45.4	28
VIII. Decomposed roots of nest epiphytes	107	36	197.2	334.9	122
IX. Litter and detritus fallen in nests	36	17	111.8	130.4	22
X. Humus accumulated in nests	308	130	136.9	271.6	353
I—X. Grand total	53,547	32,130			28,578
II—X. Total of epiphytes	4,401	2,130			14,937
IX—X. Aerial humus + litter	344	147			375

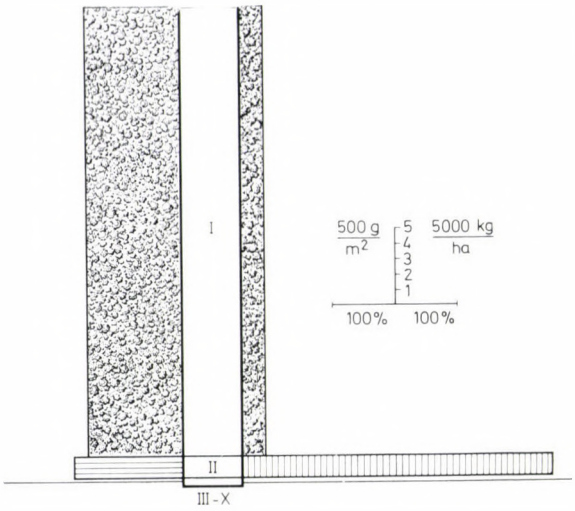

Fig. 13. The biomass of all epiphytes + phorophyte leaves and their interception capacity in one hectar submontane rain forest area. The diagram is constructed the same way as the previous ones. (Symbols see in Table 7)

them by the necessary specimen number or surface factors mentioned on page 144. My feeling is, that it is impossible to cut down a hectare of a tropical forest just for this purpose and to measure and to weight all of its epiphytes; therefore this approach is justified and provides useful data. The model has already been published briefly (Pócs, 1976: 501), but had to be modified and to be supplemented by many important records.

The data on the Table 7 are given for one hectare area, in kilograms or in litres when not in %. The sampling was carried out on 18 February 1971 and on 6—8 February 1973, with my students and laboratory assistants P. S. Mwanjabe and M. Lung'wecha, who gave me great help also in the elaboration of the collected samples.

Although the nest epiphytes are among the most striking features of tropical rain forests, there biomass here is surpassed by the biomass of smaller ramicolous epiphytes. Anyway, nest epiphytes play an important rôle in the aerial humus accumulation. The ramicolous microepiphytes (mostly bryophytes), which cover the uppermost twigs in the canopy with their feathery mass, proved to be the most effective interceptors, surmounting even the water absorption of the foliage of phorophyte trees. We carried down several square metres from the canopy and applying artificial rain, measured the water uptake of the fresh foliage and that of the bryophytic epiphytes. *Plagiochila* species are in the sample plot most important, as ramicolous canopy interceptors. The same phenomenon was observed in the lowland rain forests of

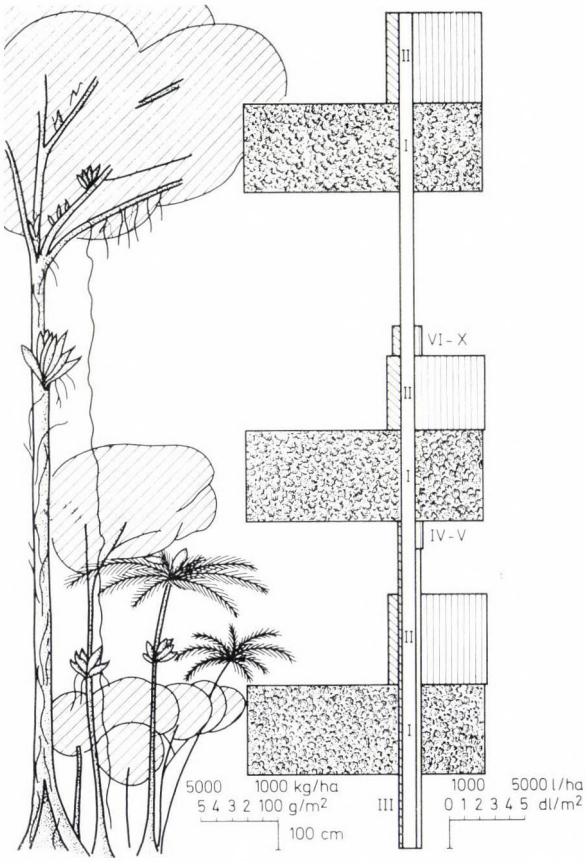

Fig. 14. The biomass and interception capacity in the submontane rain forest diagrammed in relation to the real height of the different layers. (The symbols used are the same as in Table 7)

Cuc Phuong National Park in Vietnam. In really wet forests these featherlike bryophytes, settling on twigs of a pencil diameter or less, form a quite continuous intercepting layer, which absorbs first the rain water falling on the canopy, retaining more from it, than the leaves. The leaf biomass on the sample plot was estimated as high, as 30 t/ha, which is comparable to the leaf biomass of a temperate oak forest in Hungary (4.26 t/ha according to PAPP, 1974: 337).

The total interception in our submontane rain forest is estimated to be 28 578 litres by one rain/ha. This amount, calculating 200 rainy days a year, makes 572 mm, one fifth of the annual rainfall here. HOPKINS (1970: 256—257) measured in a submontane rain forest of Uganda during a long period 33.6% interception, which is not far from our estimation. In my earlier publication (PÓCS, 1974: 501) was calculated much less, due to the fact that only one canopy layer was taken into account.

II. *Mossy elfin forest* (Figs. 15—22)

The sample area is on the top of Bondwa peak, just behind the telecommunication tower, at 2120 m altitude, on a gentle (15°) E slope. Its vegetation has been described by the author (Pócs, 1974: 125), being identical with the microclimate measuring station No. 7. The elfin woodland is formed by 4—6 m tall trees with umbrella shaped, dense canopy (up to 90%). The next layer consists of 1—2.5 m tall, half woody *Acanthaceae*, and a true herb layer follows of 10—60 cm tall plants. The moss layer is very thick, the ground is covered by cushion and carpet forming bryophytes up to 40—50%, sometimes by lichens. The sample plot is a typical representative of "mossy forests" due to the very high amount of rainfall (3000 mm well distributed almost throughout the year) and due to the effect of almost permanent cloud formation. The precipitation in the form of mist and dew compensates the short dry periods. The trunk and whole branching system of trees is covered by a very thick (up to 15 cm) bryophyte and filmy fern fur. The canopy twigs are interwoven so densely by bryophytes, that their top cover is almost continuous. Small epiphytic orchids occur among them, in great amounts, as many as 40—50 specimens/m^2. The sampling was carried out on 16 February 1971 and

Fig. 15. The elfin forest sample plot on the top of Bondwa peak, at 2120 m altitude

Fig. 16. The characteristic canopy of a *Syzygium* tree at the elfin forest edge

Fig. 17. Podocarpus milanjianus canopy interwoven by microepiphytes in the elfin forest

Fig. 18. Interior of the mossy elfin forest

Fig. 19. Dicranoloma billardieri cloak on a branch in the mossy elfin forest

Fig. 20. Water absorption from mist by the epiphytic bryophytes of the elfin forest. (*Conoscyphus trapezioides, Bazzania borbonica*, etc.)

on 25 February 1973. The data obtained from the 1 or 2 m^2 samples cut out from the different layers were simply multified and the data of table 8 refer to one hectare area.

As it can be seen, far the best interceptor is the moss cover of the canopy, its interception capacity surpassing not only the other layers of the elfin forest, but also the whole interception ability of the submontane high forest, absorbing nearly 30,000 litres of water/ha during a single rain after a relatively dry period. If we add the thick bryophyte cloak of all trunks, lianas and the ground cover, and count with, at least, 250 rainy days a year, we reach a very high value and can understand the great significance of montane mossy forests on tropical watersheds. Here the presence of mossy forest cover in the cloud zone has a buffering rôle and eliminates the deteriorating effect of torrential rains,

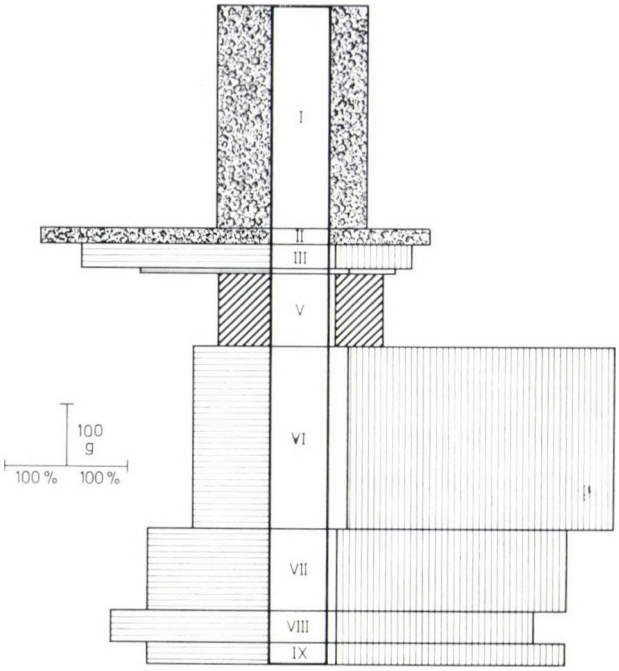

Fig. 21. The biomass/water interception diagram of the phorophyte foliage and epiphytes of one hectar mossy elfin forest. The height of white fields expresses the dry matter, the left side size the fresh matter, the white fields on the right the absorption from laboratory air, finally the stripped part on the right the water interception capacity of the different component (see Table 8)

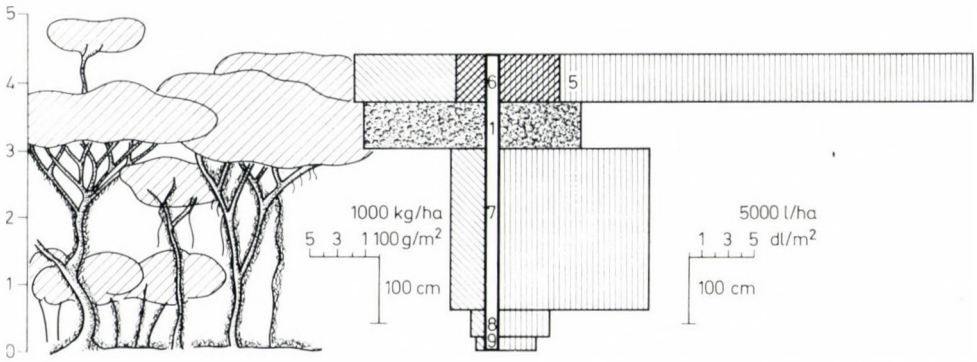

Fig. 22. The biomass and water interception of epiphytes and phorophyte leaves in the mossy elfin forest, pictured according to their real position in the different layers. (See Table 8)

allowing the rainwater only gradually to the soil and, by keeping the environment moist during dry periods, regulates the level of agriculturally important watercourses. (Not mentioning the water demand of densely populated areas. E.g. the water supply of Dar es Salaam depends on the level of Mgeta — Ruvu

Table 8

The epiphyte biomass—water interception model of the mossy elfin forest plot

	Fresh matter, kg	Dry matter, kg	Water content in dry matter %	Interception capacity	
				in dry m.%	in l/ha
I. Microphyllous leaves of *Podocarpus milanjianus*	13,594	7,488	81.5	67.5	5,055
II. Mesophyllous leaves of *Allanblackia* cf. *ulugurensis*	2,753	595	363.0	173.3	1,024
III. Epiphytic orchids in the canopy	3,305	834	296.2	145.0	1,209
IV. Epiphytic ferns (mostly *Hymenophyllaceae*) of the canopy	186	63	195.2	109.8	69
V. Humus and detritus among the canopy epiphytes	4,409	2,453	79.3	193.0	4,734
VI. Microepiphytes on branches	13,419	6,145	118.4	471.0	28,942
VII. Microepiphytes on trunks	7,062	2,780	154.0	395.0	10,981
VIII. Microepiphytes on roots	4,103	1,375	198.4	338.0	3,958
IX. Bryophyte cover on ground	2,133	723	195.0	393.0	2,841
I—IX. Grand total	50,964	22,456			58,813
III—VIII. Total of epiphytes	32,484	13,650			49,893
I—II. Total of phorophyte leaves	16,347	8,083			6,079

River, which originates farther than 200 km distance from the capital, in the Uluguru Mts.) The epiphytic humus accumulation is also very significant in the elfin forest, surpassing by more than ten times the aerial humus accumulation of the much taller and more complex submontane rain forest. The humus in the elfin forest is not bound to epiphytic nests, but, as a permanent mizzle, falls down and increases the otherwise poor nutrient reserves of the soil. Therefore in the dwarf elfin forest the canopy is not only microclimatically (light, temperature, water) the most active layer, but probably here occurs the most active humus formation too.

Rainfall—epiphyte correlation theory

Analysing the above figures and comparing then with the corresponding climatological data (see the GAUSSEN—WALTER diagrams in PÓCS, 1974: 116 and 1976: 170—171) one can find an interesting correlation between the interceptive capacity of epiphytic biomass and the distribution of annual rainfall.

The epiphytic biomass, especially its active interceptor fractions and the interception itself is proportional to the annual rainfall amount surpassing the monthly 100 mm average, which is marked by black on GAUSSEN—WALTER diagrams. The reason, why WALTER and LIETH (1960 and other publications) used this black field, is, that the increase of monthly rainfall increases the "bonity" of macrovegetation only up to a level corresponding monthly to about 100—200 mm under tropical conditions, if the rainfall is more or less evenly distributed. Above about 2000—2500 mm rainfall a year there is no further "improvement" and "enriching" of vegetation, as far as the height and general density of the forest, the biomass and the lifespan of the trees are concerned. On the contrary (cf. LONGMAN—JENIK, 1974: 10—12) in perhumid regions the growing stock of forests is well below the standard of an average rain forest or even of a seasonal rain forest.

How does the surplus rainfall effect otherwise the tropical forest? Although the general physiognomy of the host community, the "skeleton" does not change much with further increase of rainfall, its epiphytic biomass and the interceptive capacity of epiphytes increases in the ratio of the "surplus" rainfall amount. In our case the surplus rainfall is 1100 and 1910 mm, respectively. This amount is already ineffective for the host vegetation types. At other places in the same mountains there are submontane evergreen forests by much less precipitation (if evenly distributed) and elfin forests as well — but accompanied by much less epiphytes, although their tree stand and ground flora is composed of similar species. The seemingly ineffective "surplus" is utilized by the specially adopted epiphytes, which built up an active water intercepting system in the tropical forests. After intercepting the water, they reevaporate one part, allow slowly to drop and flow down an other part, finally retain in their own root system and humus filled nest or even among their leaves the third part, utilizing and incorporating it into their own body. In all the three ways they influence their environment, the host community, performing the above mentioned buffering rôle, increasing the biomass and accumulating humus. My feeling is, that the epiphytic life form is not only or not so far an adaptation to special light conditions, but more a style of life provoked by the surplus rainfall, utilising the other favourable climatic conditions in the tropics.

The epiphytic life form seems to be, at least in most cases, a late adaptation, which developed not parallel, but after the general development of rain forests since the Cretaceous. The great Angiosperm epiphyte families are on the tips of evolution lines (*Bromeliaceae*, *Orchidaceae*) and highly specialized. There is no true Gymnosperm epiphyte. There are many pteridophytes living as epiphytes, but only one family, the *Hymenophyllaceae* consist of highly specialized epiphytes, the others share their habitats between different non epiphytic and epiphytic substrates. Again the "top families", *Aspleniaceae*

and *Polypodiaceae* supply most of the epiphytes along *Hymenophyllaceae*. Among the bryophytes the most specialized epiphyllous *Lejeuneaceae* are not known yet from fossils and other members of the family known only from the Eocene. They are obviously in their optimal "acme" phase of their evolution, producing many juvenile species, highly adopted to the epiphyllous life form by water condensing, water storing, anchoring and by special vegetative reproducting organs. The same applies to a less extent to *Frullania* and to some Hookerioid mosses.

Summarizing, the epiphytic vegetation develops in the tropics to a great extent, where the increased amount of evenly distributed rainfall does not result in further improvement of the host vegetation type and an amount of "surplus" rainfall is at hand. The quantity of epiphytic biomass and its interceptive capacity is in proportion to the otherwise ineffective rainfall.

In consequence, the epiphytes form a system in the tropical rain forest and its pattern developed first of all not to obtain more light, but to receive and to intercept more water from the rainfall, which made it possible to cease their direct physical and chemical connection with the soil. Of course, adequate light (and nutrients from different sources) are inevitable for the epiphytes, but n o t the light demand was the factor, which resulted in their evolution, as it was thought for a long time. Epiphytism — is an adaptation to utilise water resources, which are generally useless for the host plant.

The special cases of mist epiphytes underline the above. As mentioned (Pócs, 1976: 491; 1978: 701), they occur in conditions, where the vegetation type reflects low or very unevenly distributed rainfall (*Brachystegia* woodland, *Acacia* savanna or even succulent semidesert scrub). The mist and dew, affecting them also during serious dry seasons, enable the often rich development of epiphytic vegetation, but does not effect the host plants rooting in the dry soil.

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SYSTEM OF ECOLOGIC AND GEOGRAPHIC LANDSCAPE CLASSIFICATION, SHOWN IN THE CENTRAL EUROPEAN REGION*

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Author explains the role of an ecological concept in the evaluation and classification of the geographical regions. Gives an interpretation of the term landscape ecology and emphasizes its conceptional importance in the nature protection, landscape architecture and land use. For characterizing and classifying ecological landscape types suggests to use the plant communities as the most adequate natural organizations of the multifacetic ecological properties of the landscapes. An ecologic and geographic classification is shown, which the higher phytosociological unit of the BRAUN-BLANQUET system correspond to each ecologic landscape types in.

Ecology means a special branch of biology, which investigates the correlation between organisms and their environment. The term *landscape ecology* was introduced into German linguistic usage by the geographer CARL TROLL, 1939 (TROLL, 1970, 1971, 1972). He intended with it, "to promote the geographical study of single phenomena of nature (climate, landforms, waters, residual soils, vegetation and fauna) further to a synoptic consideration of the natural phenomena, to a functional investigation of the correlation of single elements in nature". Today, landscape ecology in Western Germany is a special branch of "*Landespflege*", preservation of the national resources in a country, to which belong *nature protection, preservation of the countryside* and *landscape architecture*. Therefore landscape ecology is the study of the elements of landscapes and their correlations, especially of the naturally and culturally caused dispersal of plants and animals for the purpose of nature protection and preservation of the countryside. The *ecologic and geographic landscape classification* is to divide the earth's surface according to these complete criteria of geography: physical and biological principles and lastly according to the interventions of man (WESTERMANN, 1973).

To master the problem of order in concrete *documentation and information systems* the classification system, order system and retrieval system must be

* In the author's interpretation Central Europe means the macro-climate region.

joined. These three systems can best be combined as so-called *hierarchical principles*, which represent correlations like the model: *general — special* (LAISIEPEN et al., 1972). That means a higher arbitrary unit or a higher general term, from which the subsumptions are deduced by stepwise increase of modifying features. In this principle of subordination, terms of the same rank are coordinated or varied, and thus, a complete system of terms is developed. It is called *phylogenetic-tree-system*. For, we can picture that kind of systems as being tree-like. This principle is absolutely necessary for a documentary order system, which is not only formal.

Further, in the order science a branch with the purpose of pointing out the real or apparent natural relationships of the subjects (facts) which are to be ordered. The aim is a so-called *natural system* like the periodical system of chemistry or the phylogenetic system of the organisms of biology. The most important attribute for documentation is *completeness* and *unity*.

In fact, such a system can be shown (RADKE, 1973, 1976): Phenomena of the landscape can be subordinated to: *climate, geology, geomorphology, soil, vegetation, animals* and *man* (= interventions of man). Therefore, these subjects may be called the complete *landscape factors*. The correlation of these landscape factors to each other is like a *hierarchy* in the above-mentioned sequence of priority. This hierarchy of landscape factors may be represented by

a) the *content* (meaning) of terms of the landscape factors,

b) the *evolution* of the landscape factors and

c) the *present effects* of the landscape factors according to the experiences in geography: the present ecologic organisation and differentiation of the real landscapes.

In this place the hierarchy of landscape factors may only be discerned in the present effects of the landscape factors on each other, according to the experiences in geography:

With regard to all ecologic and geographic phenomena for a geographic differentiation of landscapes, *climate* comes first. Therefore, the climate geographer BLÜTHGEN (1966: 4) wrote: "Every single climatic investigation, be it related to the behaviour of an individual or a synoptical complex climatic element, is only geographically justified, if it can independently of its dimension serve as an integrating component of the edifice of a genetically grounded climate classification explaining the effects on the earth's surface."

"In the typifying climate classification there are two groups, which are based on *a)* the genesis of climates, that is the large circulation of the atmosphere with its belts and its modifications, and *b)* the effects on whatever sphere. We call them the genetic and the effective climates classifications. But we must remember, that the distinction between genetic and effective classification is not strict. Both aspects may be more or less closely interwoven."

"The effective systems are based on certain spheres of activity: soil, vegetation, run off water, inhabitability etc., but also combinations of these. With mean values or lasting values, range of fluctuations, liminal values, derived from the observed values of the climate stations, one reached a quantitative, though basically only punctual delimitation of climate-types, requiring a lot of interpolation."(BLÜTHGEN, 1966: 507, 520)

"Of the effective systems, KÖPPEN's is the most detailed, starting out with the idea, that flora and fauna are the reactions of the climate, with an extremely complex system. Further, it makes use of defined liminal or lasting values, and therefore, the increase of statistical material of observation is of benefit to its refinement." "Lastly, TROLL and PAFFEN (1964) developed a detailed climate classification of the whole earth, according to the effects learnt from the vegetation in which especially the seasonal fluctuation of weather is regarded, but also the course of day, both represented by the thermo-isopletes." According to BLÜTHGEN (1966: 537) this system represents the pinnacle of classification. The superordination of climate above *geology* and its attribution to geology is also expressed by the geologist WAGNER (1960). He said that climate is the cause of the exogenic geologic energies, he called "transformed solar energy".

The primary effect of climate followed by the effect of geology is most evident in *geomorphology*, in that we distinguish between a climatic geomorphology and a tectonic one. Therefore, the geomorphologist MACHATSCHEK (1968: 63) wrote: "A regional classification of the shapes of surface may be derived, which is closely related to the classification of the earth into climate zones and climate regions."

There are still more connections between climate geography and soil geography. So, the soil geographer GANSSEN (1972: 25) wrote, that for a zonal soil classification the climate classification could be taken as a basis. Modifications related to the parent rock he called "intrazonal soil types", which are climate related, too.

The leading German soil scientists also mention as factors for soil development climate first (MÜCKENHAUSEN, 1975: 370), secondly parent rock, thirdly geomorphology (SCHEFFER and SCHACHTSCHABEL, 1970: 311). The closest correlation between soil and vegetation was seen by the soil geographer GANSSEN (1972: 5) as follows: "The correlation of soil and vegetation is so close, that in reality it is senseless to talk about a soil without mentioning its vegetation."

The close correlation between climate and vegetation was recognized very early by the plant geographers, climate geographers and climate historians. (WALTER, 1972, 1976; WALTER and STRAKA, 1970; FRENZEL, 1967, 1968). In agreement with SCHEFFER and SCHACHTSCHABEL (1970) and WALTER (1976) we see following hierarchic order of the factors for the differentiation of the

landscapes, for the general ecologic geographic landscape differentiation and classification (RADKE, 1973, 1974, 1976):

Climate; macro-climate, climate of altitudinal zone;

Parent rock (material); dolomite, limestone, marl, basic to acid silicate material; bedrock, loose material;

Geomorphology; large to fine situation; steep to flat; sunny to shady site;

Soil; limy, marly, basic, acid; flat, deep; dry, wet; mineralic, humose, organic;

Vegetation; natural, close to natural, cultural.

For a system of general ecologic and geographic landscape classification we give a key position to the *plant community*. For that, plant sociology has given us the best foundation by definition of the plant community. (BRAUN-BLANQUET, 1964:21. ff): "An association is a plant community of distinct floristic composition, homogeneous site conditions and homogeneous physiognomy" (Brussels 1910). In Amsterdam 1935 it was laid down to reserve the name of association especially for the vegetation unit, characterized by *character species* and *differential species*. In Stockholm 1950 the desirability of subsumption of the floristically related associations to superior units: *alliances*, *orders* and *classes*, was officially accepted.

In the nomenclature of plant communities, it has become customary to add a Latin suffix to the genus name of a character species, and the species name assumes the genitive. The following systematic graduations are accepted by the large majority of present-day sociologists:

Classification Units	Suffix
Class	-etea
Order	-etalia
Alliance	-ion
Association	-etum
Subassociation	-etosum, added to the genus name of another species
Variant	-variant, added to the genus name of another species
Facies	-facies, added to the genus name of another species

In Paris (1954) the following formulation was accepted: "La phytosociologie est l'étude des communités végétales du point de vue floristique, écologistique, dynamique, chorologique et historique." That means, that each plant community has to be delimitated by character and differential species simultaneously with its corresponding soil location, which is characterized by the defined landscape factors.

In such a way, the unity of vegetation unit and landscape unit results in an ecologic landscape unit, to which may be related the whole animal life and the activities of man, especially in view of nature protection and preservation of the countryside. Now, the documentation of the naturally and culturally caused dispersal of plant- and animal-species for nature protection is possible in the optimal way.

An integral disposition towards an ecologic, geographic and floristic system of vegetation and landscape units leads to the conclusion, and moreover it is documentarily necessary, to relate the highest classification unit, the *class*, to the clearly delimitated *macro-climate region*. With regard to this, we agree with the climate geographers, who work to delimitate the homogeneous climate region by every effect of climate.

With this precondition it is possible and commendable, generally to relate the next classification unit, the *order*, to the *climate of altituldinal zone*, and the next one, the *alliance*, to the *parent rock* with regard to nutritive substance content of the material. It has proved to be very useful and also practical to unify the very similar floristic association of the same region as well as the parent rock and *soil humidity* to the next higher classification unit of the *suballiance*. Lastly, the plant *association* results, due to the character species in each case, in connection with the defined macro-climate region, altitudinal zone, parent rock, surface condition and *soil location*. Floristic differences within this macro-climate region, characterized by character species result in regional associations, *regionals;* floristic differences characterized by differential species result in *vicariants;* fewer floristic differences result in *races* (PASSARGE, 1964; PASSARGE and HOFMANN, 1968; HARTMANN and JAHN, 1967).

According to TROLL and PAFFEN (1964) Central Europe belongs to the climate type III_3. III is the "moderately cool zone", from that is $_3$ the "suboceanic wooded region" with the "suboceanic summer broad-leafed and mixed forests". The climate data are: climate fluctuation 16—25 °C; mild to moderately cold winters; the coldest month's mean temperature is +2 to —3 °C; autumn- to summer-precipitation-maximum; moderately warm to warm long summers; vegetation period more than 200 days.

A pronounced modification of the macro-climate region apart from the slight differences of the three subregions (HARTMANN and JAHN, 1967), Central Europe is subject to the different altitudes. These differences effected by the climate of altitudinal zone are more or less sharply delimitable by forest steps (HARTMANN and SCHNELLE, 1971). In Central Europe the following altitudinal zones have been distinguished (OBERDORFER, 1962; HARTMANN and JAHN, 1967; ZUKRIGL, 1973):

Altitudinal Zones	Boundary Lines of Altitudinal Zones in Metres above Sea-level
Low Land an Hilly Country Region	
	ca. 500 (400— 600)
Mountainous Region	
	ca. 900 (700—1000)
High Mountainous and Subalpine Region	
	ca. 1800
Alpine Region	

Within these boundaries after the above-mentioned principles following list of higher vegetation (= ecologic landscape) units can be arranged:

List of Higher Vegetation (= Ecologic Landscape) Units of Central Europe

1. Natural and close to natural vegetation: FAGETEA SILVATICAE
1.1. Low land and hilly country region: **Quercetalia roboris** et **petraeae**
1.1.1. Terrestrial and weakly hydromorphic soils: **Quercetalia roboris** et **petraeae**
1.1.1.1. Limy and basic eutrophic soils: *Carpinion betuli*
1.1.1.1.1. Dry soils: *Euphorbio cyparissiae-Carpinion*
1.1.1.1.2. Moderately dry soils: *Mercuriali perennis-Carpinion*
1.1.1.1.3. Fresh soils: *Aro maculati-Carpinion*
1.1.1.1.4. Moist soils: *Stachyo silvaticae-Carpinion*
1.1.1.1.5. Gorges; fresh to moist moving soils: *Tilion*
1.1.1.2. Mesotrophic soils: *Quercion roboris* et *petraeae*
1.1.1.2.1. Dry soils: *Festuco ovinae-Quercion*
1.1.1.2.2. Moderately dry soils: *Dactylido polygamae-Quercion*
1.1.1.2.3. Fresh to moist soils: *Stellario holosteae-Quercion*
1.1.1.3. Oligotrophic strongly acid soils: *Betulion pendulae*
1.1.1.3.1. Dry soils: *Pino silvestris-Betulion*
1.1.1.3.2. Moderately dry soils: *Melampyro pratensis-Betulion*
1.1.1.3.3. Fresh to moist soils: *Molinio coeruleae-Betulion*
1.1.2. Riverain and lowland woodland with semiterrestrial soils: **Fraxinetalia excelsae**
1.1.2.1. Riverside bushes: *Salicion purpureae*
1.1.2.2. Riverain weed-tree forest, often overflooded: *Salicion albae*
1.1.2.3. Lowland rarely overflooded, hardwood forest: *Fraxinion excelsae*
1.1.3. Bogs with wet peat soils: **Alno glutinosae-Sphagnetalia**
1.1.3.1. Basic eutrophic soils: *Irido pseudacori-Alnion*
1.1.3.2. Mesotrophic soils: *Sphagno-Alnion*
1.1.3.3. Oligotrophic soils of high-moor woodland: *Betulion pubescentis*
1.1.3.4. Dystrophic high-moor plain vegetation: *Sphagnion rubelli*
1.1.4. Riverside plains: **Phalaridetalia arundinaceae**
1.1.4.1. Veil and hem vegetation: *Convolvulion sepii*
1.1.4.2. Reeds: *Phalaridion arundinaceae*
1.1.4.3. Perennial plant communities of flood-lawns, washed border and bank cracks: *Agrostion stoloniferae*
1.1.4.4. Annual pioneer communities of banks, periodically drying up: *Chenopodion fluviatilis*

1.1.5. Shores of lakes and pools and slow flowing waters, mainly eutrophic plains (mesotrophic to dystrophic see 1.2.5.): **Phragmitetalia communis**
1.1.5.1. Often overflooded peat soils: *Caricion elatae*
1.1.5.2. Mineral soils, mostly below the water level; reeds: *Phragmition communis*
1.1.5.3. Perennial crawling lawn of washed borders: *Rumicion crispi*
1.1.5.4. Annual plant communities of in summer occasionally dry shores: *Bidention tripartiti*
1.1.6. Running waters aquatic communities: *Ranunculetalia fluitantis*
1.1.7. Lakes and ponds and slow flowing waters aquatic communities, eu- to mesotrophic (oligotrophic see 1.2.7.): **Potamogetonetalia lucentis** (*Potametalia lucentis*)
1.1.7.1. Waters with very fluctuating water level: *Ranunculion aquatilis*
1.1.7.2. Calm waters, sheltered from wind; floating small-leaved plant communities, rooted in water: *Lemnion trisculae*
1.1.7.3. Flat waters to depth of 2 m with calm surface; floating plant communities, anchored to the boddom: *Nymphaeion albae*
1.1.7.4. Waters with depth to 3 m and dynamic surface; mainly submerged plant communities: *Potamion lucentis*
1.2. Mountainous region: **Abieti albae-Fagetalia silvaticae**
1.2.1. Terrestrial and weakly hydromorphic soils: **Abieti albae-Fagetalia silvaticae**
1.2.1.1. Limy and basic eutrophic soils: *Fagion silvaticae*
1.2.1.1.1. Dry soils: *Carici albae-Fagion*
1.2.1.1.2. Fresh limy soils: *Lathyro verni-Fagion*
1.2.1.1.3. Fresh basic soils: *Dentario bulbiferae-Fagion*
1.2.1.1.4. Moist deep soils: *Impatienti-Fagion*
1.2.1.1.5. Fresh to moist moving soils of steep slopes: *Acerion pseudoplatani*
1.2.1.2. Acid oligotrophic soils: *Abietion albae*
1.2.1.2.1. Dry soils: *Cladonio-Abietion*
1.2.1.2.2. Fresh soils: *Luzulo luzuloidis-Abietion*
1.2.1.2.3. Moist soils: *Sphagno-Abietion*
1.2.2. Riverain and lowland woodland with semiterrestrial soils: **Prunetalia padi**
1.2.2.1. Riverside bushes: *Salicion eleagni*
1.2.2.2. Riverain woodland, often overflooded: *Alnion incanae*
1.2.2.3. Trickling wet eutrophic mineral to humose soils, seasonally overflooded: *Carici remotae-Padion*
1.2.3. Bogs with wet peat soils, here most oligotrophic to dystrophic (eutrophic see 1.1.3.): **Vaccinietalia uliginosi**
1.2.3.1. Light and low woodland: *Pino silvestris-Vaccinion*
1.2.3.2. High-moors, bog hillock, open plains: *Sphagnion medii*
1.2.4. Riverside plains: **Petasitetalia hybridi**
1.2.4.1. Veil and hem communities, leaning against the riverside bushes and reeds: *Petasition hybridi*
1.2.4.2. Perennial plant communities of reeds and flood lawns: *Nasturtion officinalis*
1.2.4.3. Annual pioneer communities of periodically dry river banks: *Chondrillion chondrilloidis*
1.2.5. Shore plains of lakes and ponds: **Caricetalia rostratae**
1.2.5.1. Limy and basic wet peat soils seasonally overflooded: *Tofieldion calyculatae*
1.2.5.2. Meso- to oligotrophic muddy swamps with floating lawn communities: *Eriophorion gracilis*
1.2.5.3. Meso- to oligotrophic muddy shores with reed communities: *Caricion rostratae*
1.2.5.4. Periodically dry bare peat and shore sand soils: *Rhynchosporion albae*

1.2.5.5. Meso- to oligotrophic wet peat soils: *Caricion canescentis*
1.2.6. Running waters aquatic communities: **Fontinaletalia antipyreticae**
1.2.6.1. Limy waters: *Siion erecti submersi*
1.2.6.2. Oligotrophic waters: *Callitrichion hamulatae*
1.2.7. Aquatic communities of lakes and ponds and slow flowing waters: **Potamogetonetalia filiformis** (*Potametalia f.*) (or *Nymphaeetalia minoris*)
1.2.7.1. Limy oligo- to mesotrophic waters from 1 to 20 m depth with sandy to muddy ground: *Charion asperae*
1.2.7.2. Acid sandy flat shores, partly seasonally dry: *Littorellion uniflorae*
1.2.7.3. Bog pools: *Utricularion minoris*
1.2.7.4. Eu- to mesotrophic waters of about 1 m depths with muddy ground; floating leaf plant communities anchored to the bottom: *Nymphaeion minoris*
1.2.7.5. Eu- to mesotrophic waters with dynamic surface, mainly submerged living plant communities: *Potamion filiformis*
1.2.7.6. Calm waters sheltered from wind; small leaf floating communities, rooted in water: *Lemnion minoris*
1.3. High-mountainous and subalpine region: **Piceetalia abietis**
1.3.1. Terrestrial soils: **Piceetalia abietis**
1.3.1.1. Limy and basic soils: *Adenostylo glabrae-Piceion*
1.3.1.1.1. Steep slopes with dry soils: *Erico carneae-Piceion*
1.3.1.1.2. Fresh soils: *Adenostylo glabrae-Piceion*
1.3.1.1.3. Moist soils: *Adenostylo alliariae-Piceion*
1.3.1.1.4. Fresh to moist shady rich mull soils: *Aceri pseudoplatani-Piceion*
1.3.1.2. Acid soils: *Homogyno alpinae-Piceion*
1.3.1.2.1. Dry soils: *Cladonio-Piceion*
1.3.1.2.2. Fresh soils: *Calamagrostidi villosae-Piceion*
1.3.1.2.3. Moist soils: *Athyrio alpestris-Piceion*
1.3.1.3. Extreme soils at the wood border: *Pinion mugi*
1.3.2. Riverain and moving slopes woodland: **Alnetalia incanae**
1.3.3. Boggy soils: **Sphagno-Piceetalia**
1.3.4. Open plains of rubble slopes: **Tussilaginetalia farfarae**
1.3.5. Riverside open plains: **Epilobietalia fleischeri**
1.3.6. Lake shore plains: **Sparganietalia angustifolii**

2. Culturally caused bush and forest mantle communities: PRUNETEA SPINOSAE
2.1. Low land and hilly country region: **Prunetalia spinosae**
2.1.1. Terrestrial soils: **Prunetalia spinosae**
2.1.1.1. Limy soils: *Berberidion vulgaris*
2.1.1.2. Basic rich soils: *Prunion spinosae*
2.1.1.3. Oligotrophic acid soils: *Rhamnion frangulae*
2.1.2. Semiterrestrial soils: **Viburnetalia opuli**
2.1.3. Peat soils: **Salicetalia cinereae**
2.2. Mountainous region: **Coryletalia avellanae**

3. Nurse- and pioneer-wood communities: SALICETEA CAPREAE
3.1. Low land and hilly country region: **Salicetalia capreae**
3.1.1. Terrestrial soils: **Salicetalia capreae**
3.1.2. Semiterrestrial soils: **Sambucetalia nigrae**
3.2. Mountainous region: **Sambucetalia racemosae**

4. Clear-cutting communities: EPILOBIETEA ANGUSTIFOLIAE
4.1. Low land and hilly country region: **Epilobietalia angustifoliae**
4.1.1. Terrestrial soils: **Epilobietalia angustifoliae**
4.1.1.1. Limy and basic rich soils: *Atropion bella-donnae*
4.1.1.2. Acid soils: *Epilobion angustifoliae*
4.1.2. Semiterrestrial soils: *Arction nemorosi*
4.2. Mountainous region: **Senecionetalia fuchsii**

5. Culturally caused forest hem communities: AEGOPODIETEA PODAGRARIAE
5.1. Low land and hilly country region: **Aegopodietalia podagrariae**
5.1.1. Terrestrial soils: **Aegopodietalia podagrariae**
5.1.1.1. Limy dry soils: *Geranion sanguinei*
5.1.1.2. Basic rich dry soils: *Trifolion medii*
5.1.1.3. Fresh basic rich soils: *Aegopodion podagrariae*
5.1.1.4. Acid soils: *Teucrion scorodoniae*
5.1.2. Semiterrestrial soils: **Filipenduletalia ulmariae**
5.2. Mountainous region: **Geranietalia silvatici**
5.2.1. Terrestrial soils: **Geranietalia silvatici**
5.2.1.1. Limy soils: *Laserpition latifolii*
5.2.1.2. Basic rich soils: *Geranion silvatici*
5.2.1.3. Acid soils: *Geranion robertiani*
5.2.2. Semiterrestrial soils: **Chaerophylletalia hirsuti**
5.3. High-mountainous and subalpine region: **Adenostyletalia alliariae**

6. Extensively utilized (by mowing or pasture) open area: FESTUCETEA OVINAE
6.1. Low land and hilly country region: **Festucetalia ovinae**
6.1.1. Terrestrial soils mostly extensively pastured: **Festucion ovinae**
6.1.1.1. Limy and basic rich soils: *Brachypodion pinnati*
6.1.1.1.1. Dry flat and open soils on rocks, crests, tops and rubble: *Alyssion saxatilis*
6.1.1.1.2. Sandy soils: *Koelerion glaucae*
6.1.1.1.3. Dry open loamy soils: *Bromion erecti*
6.1.1.2. Acid soils: *Festucion ovinae*
6.1.1.2.1. Dry flat soils of crests and tops, pioneer vegetation: *Veronicion dillenii*
6.1.1.2.2. Dune sands, open pioneer vegetation: *Corynephorion canescentis*
6.1.1.2.3. Consolidated sandy and gravelly soils, closed lawns: *Festucion ovinae*
6.1.1.2.4. Sandy-loamy moderately fresh soils: *Callunion vulgaris*
6.1.2. Semiterrestrial soils mostly irregularly mowed: **Filipenduletalia ulmariae**
6.1.2.1. Riverain lowland, often dry soils: *Peucedanion officinalis*
6.1.2.2. Sandy and loamy moist soils: *Filipendulion ulmariae*
6.1.2.3. Limy wet and springly soils: *Schoenion nigricantis*
6.1.2.4. Humose wet clay soils: *Caricion gracilis*
6.1.3. Peat soils: **Molinietalia coeruleae**
6.1.3.1. Limy and basic rich peat soils: *Serratulion tinctoriae*
6.1.3.2. Acid peat soils: *Succision pratensis*
6.2. Mountainous region: **Nardetalia strictae**
6.2.1. Terrestrial soils extensively pastured: **Nardetalia strictae**
6.2.1.1. Limy and basic rich soils: *Seslerion variae*
6.2.1.1.1. Dry flat soils of rocks, crests and tops; open pioneer plant communities: *Sedion albi*
6.2.1.1.2. Dry soils of rubble materials: *Vincetoxion officinalis*
6.2.1.1.3. Fresh limy soils: *Seslerion variae*

6.2.1.2. Acid silicate soils: *Nardion strictae*
6.2.1.2.1. Silicate rocks, split vegetation: *Asplenion septentrionalis*
6.2.1.2.2. Dry flat soils of rubble plains: *Galeopsion segeti*
6.2.1.2.3. Sandy-loamy soils, closed lawns: *Nardion strictae*
6.2.2. Semiterrestrial soils mostly irregularly mowed: **Juncetalia conglomerati**
6.2.2.1. Riverside soils: *Petasition hybridi*
6.2.2.2. Riverain and lowland: *Eu-Molinion coeruleae*
6.2.2.3. Acid moist humose soils: *Juncion squarrosi*
6.2.3. Spring plains with trickled wet soils irregularly mowed: **Cardaminetalia amarae**
6.2.3.1. Calcereous tufa soils: *Cratoneurion commutati*
6.2.3.2. Limy boggy soils: *Chrysohypnion stellati*
6.2.3.3. Basic rich soils: *Montion fontanae*
6.2.3.4. Acid soils: *Juncion acutiflori*
6.2.4. Peat soils, irregularly mowed: **Eriophoretalia angustifolii**
6.2.4.1. Limy and basic soils: *Eriophorion latifolii*
6.2.4.2. Acid soils: *Caricion fuscae*

7. Green meadows, intensively utilized, cut more than once a year: ARRHENATHERETEA ELATIORIS
7.1. Low land and hilly country region: **Arrhenatheretalia elatioris**
7.1.1. Terrestrial soils: **Arrhenatheretalia elatioris**
7.1.2. Semiterrestrial soils: **Cirsietalia oleracei**
7.1.3. Peat soils: **Calthetalia palustris**
7.2. Mountainous region: **Trisetetalia flavescentis**
7.2.1. Terrestrial soils: **Trisetetalia flavescentis**
7.2.2. Semiterrestrial soils: **Polygonetalia bistortae**
7.3. High-mountainous and subalpine region: **Astrantietalia majoris**

8. Rich pastures, intensively utilized: CYNOSURETEA CRISTATAE
8.1. Low land and hilly country region: **Lolietalia perennis**
8.1.1. Terrestrial soils: **Lolietalia perennis**
8.1.2. Semiterrestrial soils: *Potentillion anserinae*
8.2. Mountainous region: **Cynosuretalia cristatae**
8.2.1. Terrestrial soils: **Cynosuretalia cristatae**
8.2.2. Semiterrestrial soils: **Juncetalia effusi**

9. Paths and places with open soils stepped on: PLANTAGINETEA MAJORIS
9.1. Low land and hilly country region: **Plantaginetalia majoris**
9.1.1. Terrestrial soils: **Plantaginetalia majoris**
9.1.1.1. Dry soils farthest against the middle of paths open soils: *Polygonion avicularis*
9.1.1.2. Fresh sandy and slaggy pathe: *Saginion procumbentis*
9.1.2. Semiterrestrial soils: **Juncetalia compressi**
9.2. Mountainous region: **Poetalia annuae**
9.3. High-mountainous and subalpine region: **Poetalia supinae**

10. Older fallow land and other secondary localities with perennial mostly closed vegetation: ARTEMISIETEA VULGARIS
10.1. Low land and hilly country region: **Artemisietalia vulgaris**
10.1.1. Terrestrial soils: **Artemisietalia vulgaris**

10.1.1.1. Limy and basic rich soils: *Verbascion thapsi*
10.1.1.1.1. Dry mostly limy soils: *Onopordion acanthii*
10.1.1.1.2. Fresh soils: *Arction lappae*
10.1.1.2. Silicate poorer soils: *Berteroion incanae*
10.1.1.2.1. Dry soils: *Berteroion incanae*
10.1.1.2.2. Fresh soils: *Agrostion tenuis*
10.1.2. Semiterrestrial soils: **Rumicetalia obtusifolii**
10.2. Mountainous region: **Chenopodietalia boni-henrici**
10.2.1. Terrestrial soils: **Carduetalia nutantis**
10.2.2. Semiterrestrial soils: **Chenopodietalia boni-henrici**

11. Young fallow land and other secondary open localities with ruderal pioneer partly annual plant communities: CAPSELLETEA BURSAE-PASTORIS prov.
11.1. Low land and hilly country region
11.1.1. Terrestrial soils
11.1.1.1. Limy and basic rich soils
11.1.1.1.1. Wall joints vegetation: *Cymbalarion muralis*
11.1.1.1.2. Rubble, crests and tops of roofs and walls, railroad-embankment: *Alyssion alyssoidis*
11.1.1.1.3. Ruins, rubbish, dust and freshly made dams: *Sisymbrion officinalis*
11.1.1.1.4. Young fallow land: *Agropyrion repentis*
11.1.1.2. Acid silicate soils: *Chondrillion junceae*
11.1.1.2.1. Dry flat soils of rubble, crests, walls and railroad-embankment; initial pioneer-vegetation: *Sedion rupestris*
11.1.1.2.2. Young fallow land: *Chondrillion junceae*
11.1.2. Semiterrestrial soils: **Ranunculetalia repentis**
11.2. Mountainous region: **Sedetalia acris**
11.2.1. Terrestrial soils: **Sedetalia acris**
11.2.1.1. Limy and basic rich soils: *Sedion albi*
11.2.1.1.1. Wall joints vegetation: *Asplenion trichomanis*
11.2.1.1.2. Dry soils of rubble, crests and tops of roofs and walls: *Sedion albi* (or *Sempervivion tectori*)
11.2.1.1.3. Loamy soils: *Bromion sterilis*
11.2.1.2. Acid silicate soils: *Sedion acris*
11.2.2. Semiterrestrial soils: **Peucedanetalia ostruthii**

12. Winter crops weed communities: SECALINETEA
12.1. Low land and hilly country region: **Secalinetalia**
12.1.1. Terrestrial soils: **Secalinetalia**
12.1.1.1. Limy and basic rich soils: *Caucalidion lappulae*
12.1.1.2. Acid loamy soils: *Aphanion arvensis*
12.1.1.3. Acid sandy soils: *Arnoserion minimae*
12.1.2. Semiterrestrial soils: **Menthetalia arvensis**
12.2. Mountainous region: **Galeopsietalia tetrahit**
12.2.1. Limy soils: *Neslion paniculatae*
12.2.2. Silicate soils: *Galeopsion segeti*

13. Summer crops and root crops weed communities: CHENOPODIETEA ALBI
13.1. Low land and hilly country region: **Chenopodietalia albi**
13.1.1. Terrestrial soils: **Chenopodietalia albi**
13.1.1.1. Limy soils: *Veronicion politae*

13.1.1.2. Basic rich soils: *Fumarion officinalis*
13.1.1.3. Acid loamy soils: *Oxalidion strictae*
13.1.1.4. Acid sandy soils: *Setarion*
13.1.2. Semiterrestrial soils: **Stachyetalia palustris**
13.2. Mountainous region: **Galeopsietalia speciosae**

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DIE BUCHENWÄLDER DES BÜKK-GEBIRGES (NO-UNGARN) IM VERGLEICH MIT DENEN DES PLEISTOZÄNS DER DDR

Von

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(Eingegangen: 1. Mai, 1979)

Author making a comparison between the floral compositions of two beechwoods (that of the Bükk-Mountains in north-eastern Hungary and the Pleistocene ones in the GDR) concludes their similarity is based on the common mesotrophic elements. The beech woods of the Bükk Mountains are characterized by their South-European, Southeast-European and eastern-continental elements suggesting to consider them as a separate forest association. In contrast the East-German pleistocene beechwoods have subatlantic, subboreal and subcontinental elements as characteristic features.

In seiner grundlegenden Arbeit über die forstwirtschaftlichen Ergebnisse der geobotanischen Kartierung im Bükk-Gebirge befaßt sich B. ZÓLYOMI (1954, 1955) eingehend mit den Vegetationseinheiten der dortigen Wälder und ihrer Auswertung als Grundlage für die Forstwirtschaft.

Da, wie schon der Name dieses Gebirges sagt, die Buchenwälder dort eine große Fläche einnehmen und der Verfasser dieser Zeilen mitten in einem großen Buchengebiet seit Jahrzehnten lebt, erscheint es reizvoll, einen Vergleich dieser Waldgesellschaften zu ziehen.

Der Vergleich ist in zweifacher Hinsicht interessant. Wie wirkt sich die große Entfernung beider Buchengebiete auf die Artengarnitur aus, und wie macht sich der Unterschied in den Höhenstufen bemerkbar, denn im Bükk-Gebirge ist es die submontane und montane Stufe und hier die flachländische. Obwohl klimatisch gesehen, Ähnlichkeiten vorhanden sind, wie in der Temperatur, in der Niederschlagshöhe und in der Niederschlagsverteilung, sind doch bestimmte Unterschiede gegeben, die auf die Anwesenheit von Arten Einfluß nehmen.

Von den Grundgesteinen her gesehen, ist im Bükk-Gebirge der Kalk vorherrschend, doch kommen auch Tonschiefer, Kieselschiefer und Quarzite vor. Bei den Böden handelt es sich um schwach podsolierte Braunerden und primäre Podsole, so daß nach den Bodentypen die Ähnlichkeiten vorhanden sind.

Doch wären bestimmte Waldgesellschaften vom Vergleich auszuschließen, da deren Analogon im Pleistozän nicht gegeben ist, so das *Seslerio-Fagetum* und das *Phyllitidi-Aceretum*, ein an Buche reicher Steilhangwald.

Zum Vergleich bieten sich an das *Aconito-Fagetum subcarpaticum*, das *Melitti-Fagetum subcarpaticum*, sowie das *Deschampsio-Fagetum*, wie sie Soó 1962 konzipiert hat und dessen Tabellen zugrunde gelegt werden. Sie werden ergänzt durch die Tabellen von MAGYAR (1933).

Aus dem Pleistozän werden herangezogen das *Fraxino-Fagetum*, das *Mercuriali-Fagetum*, das *Melico-Fagetum*, das *Asperulo-Fagetum*, sowie das *Petraeo-*, das *Myrtillo-* und das *Leucobryo-Fagetum*.

Stellt man zunächst die gemeinsamen Arten in den Vordergrund, so sind neben der herrschenden *Fagus silvatica, Tilia plathyphyllos, Ulmus scabra, Carpinus betulus, Acer pseudoplatanus, Acer campestre, Acer platanoides, Fraxinus excelsior, Quercus petraea* und als Seltenheit *Sorbus torminalis* gegeben.

An Sträuchern sind anzutreffen *Cornus sanguinea, Corylus avellana, Crataegus, Lonicera xylosteum, Ribes uva-crispa, Rubus fruticosus, Rubus idaeus, Evonymus europaeus, Sambucus nigra,* wobei in geschlossenen Buchenbeständen die Strauchschicht vollständig fehlen kann.

Bei den gemeinsamen Arten der Bodenvegetation kann man stete und herrschende Arten, die man als Hauptarten bezeichnen kann, zunächst herausstellen. Es sind dies: *Aegopodium podagraria, Galium odoratum, Dentaria bulbifera, Epilobium montanum, Geranium robertianum, Hordelymus europaeus, Lathyrus vernus, Mercurialis perennis, Mycelis muralis, Pulmonaria officinalis, Stachys silvatica, Stellaria holostea, Ajuga reptans, Bromus benekeni, Dactylis glomerata* und *D. polygama, Dryopteris filix-mas, Hedera helix, Melica uniflora, Poa nemoralis, Polygonatum multiflorum, Veronica chamaedrys, Viola silvatica, Alliaria officinalis, Chaerophyllum temulum, Galium aparine, Geum urbanum, Lapsana communis, Polygonatum odoratum, Veronica officinalis.*

Beim ärmeren Flügel sind es *Vaccinium myrtillus, Antennaria dioica, Calamagrostis arundinacea, Deschampsia (Avenella) flexuosa, Hieracium murorum, Phyteuma spicatum, Polypodium vulgare.*

Beim reicheren Flügel kommen aber eine ganze Reihe von Arten geringerer Konstanz und Artmächtigkeit, die aber das Bild abrunden. Von ihnen seien genannt: *Actaea spicata, Adoxa moschatellina, Campanula trachelium, Cardamine impatiens, Carex digitata, Carex silvatica, Circaea lutetiana, Daphne mezereum, Festuca altissima, Festuca gigantea, Lamium galeobdolon* coll., *Lilium martagon, Milium effusum, Oxalis acetosella, Paris quadrifolia, Ramunculus lanuginosus, Sanicula europaea, Agropyrum caninum, Arum maculatum, Athyrium filix-femina, Brachypodium silvaticum, Campanula rapunculoides, Cephalanthera damasonium, Cephalanthera rubra, Convallaria majalis, Digitalis grandiflora, Dryopteris carthusiana, Epipactis helleborine, Festuca heterophylla, Heracleum spondylium, Hypericum montanum, Impatiens noli-tangere, Majanthemum bifolium, Moehrigia trinervia, Neottia nidus-avis, Platanthera bifolia, Primula veris, Scrophularia nodosa, Vicia dumetorum, Carex remota, Urtica dioica, Myosotis silvatica.* Gelegentlich dringen auch *Lathyrus niger, Campa-*

nula persicifolia, Melampyrum nemorosum, Viola hirta und *V. mirabilis* in diese Wälder ein.

Es ist eine ansehnliche Liste, wobei die Verteilung auf die oben genannten Assoziationen verschieden ist.

Bei den Arten, die in den Buchenwäldern des Bükk-Gebirges aber nicht in denen des Pleistozäns der DDR vorkommen, kann man verschiedene Gruppen erkennen.

So sind es zunächst Arten mit größerer Stetigkeit, zuweilen auch Artmächtigkeit, aber auch Arten geringeren Vorkommens, man möchte sie als Weiserarten bezeichnen, die das spezifische südöstlich-mitteleuropäische Moment kennzeichnen, dann Arten, die auf die submontan-montane Höhenstufe im Bükk-Gebirge hinweisen.

Von der ersteren Gruppe sei zunächst *Helleborus purpurascens* erwähnt, nach ADAMOVIĆ ein pannonischer Endemit. Als eine südöstliche Sippe ist *Glechoma hirsuta* für diese Wälder sehr bezeichnend. Hinzu kommt *Euphorbia amygdaloides*, eine thermophile Halbschattenpflanze mit submediterran-pontischem Schwerpunkt, *Carex pilosa* mit sarmatischer Hauptverbreitung, hier schließen sich auch *Galium schultesii* und *Evonymus verrucosus*, letztere mit geringer Stetigkeit an. Gleichfalls mit geringer Stetigkeit schließen sich Arten südlicher-südöstlicher-östlicher Verbreitungstendenz an, die im Einzelnen verschiedene Areale aufweisen können, auf den oben erwähnten Charakter jedoch hinweisen. Zu nennen wären: *Aconitum gracile* und *A. moldavicum, Geum aleppicum, Hesperis matronalis candida, Ranunculus cassubicus, Scopolia carniolica, Waldsteinia geoides, Geranium phaeum, Isopyrum thalictroides, Omphalodes scorpioides, Galium vernum, Melittis grandiflora, Symphytum tuberosum.* Im *Deschampsio-Fagetum* sind es *Cytisus nigricans* und *Chrysanthemum corymbosum.*

Aus der Sicht der planaren Stufe wird der montane Charakter der Buchenwälder des Bükk-Gebirges durch folgende Arten gekennzeichnet: *Chaerophyllum hirsutum, Clematis alpina, Polygonatum verticillatum, Prenanthes purpurea, Senecio fuchsii* und *S. nemorensis, Anthriscus nitida, Luzula luzuloides, Astrantia major.*

Weiterhin fehlen Schluchtwaldarten wie *Lunaria rediviva, Phyllittis scolopendrium* und Arten wie *Petasites albus, Aethusa cynapium, Clematis vitalba, Cornus mas, Rosa pendulina.*

Im den Buchenwäldern des Bükk-Gebirges fehlen dagegen eine ganze Reihe von Arten, die in den Buchenwäldern des Pleistozäns vorkommen.

Von den Baumarten ist es *Quercus robur*, die als eine Art des planaren und kollinen Stufen nicht so hoch ins Gebirge geht. Auch die im Tiefland verbreiteten *Quercus petraea* und *Tilia cordata* kommen nur gelegentlich im *Melitti-Fagetum* vor. Auch spezifisch atlantisch-subatlantische Arten, wie *Ilex aquifolium, Lonicera periclymenum, Gagea spathacea*, wie auch *Trientalis*

europaea und *Dicranum majus* mit boreal-montanen Einschlag. Das im Bükk-Gebirge fehlende *Galium silvaticum* kann man als Pendant zu *Galium schultesii* betrachten.

Aus dem reicheren Flügel der Tieflandsbuchenwälder kann man aufführen: *Anemone ranunculoides*, und *A. nemorosa, Gagea lutea, Hepatica nobilis, Stellaria nemorum, Vicia silvatica, Anthriscus silvestris, Ficaria verna, Orchis fuchsii, Lysimachia nemorum, Platanthera chlorantha, Vicia sepium, Phegoptris connectilis.*

Aus dem ärmeren Teil fehlen im Bükk-Gebirge *Luzula pilosa, Lathyrus montanus, Deschampsia caespitosa, Carex pilulifera, Lycopodium annotinum, Carex montana, Melica nutans, Sorbus aucuparia* und *Pinus silvestris.*

Faßt man das Gemeinsame und das Trennende der Buchenwälder zusammen, so würden unter Berücksichtigung der Stetigkeit und der Artmächtigkeit die Momente noch besser herauskommen. Das Gemeinsame dokumentiert sich auf der Ordnungs- und Verbandsebene, wo der reichste Flügel zu den *Fraxinetalia* und dem *Fraxino-Fagion*, die mehr mesotrophen zu den *Carpino-Fagetalia* und zum *Asperulo-Fagion* und die ärmeren zu den *Luzulo-Fagetalia* und zum *Luzulo-Fagion* zu rechnen sind.

Durch den Anteil der südlichen, südöstlichen und östlichen Arten sowie der mitteleuropäischen Gebirgsarten sind die Buchenwälder des Bükk-Gebirges eindeutig als eigene Assoziationen gekennzeichnet. Die Buchenwälder des Pleistozäns der DDR weisen typisch mitteleuropäische Assoziationen auf, die im westlichen Teil subatlantischen, im nördlichen Teil subborealen und im östlichen Teil einen schwach subkontinentalen Einfluß zeigen, die als geographische Rassen zu werten sind.

Die Assoziationen selbst, wie auch ihre Untereinheiten bilden, wie es Zólyomi (1954, 1955) in seiner grundlegenden Arbeit gezeigt hat, wichtige Grundlagen für die Forstwirtschaft, da sie die Standortsbedingungen objektiv erkennen lassen und aus ihrer Dynamik wichtige Schlüsse für den Waldbau zu ziehen sind.

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ZUR FRAGE VEGETATIONSGEOGRAPHISCHER RAUMEINHEITEN

Von

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The aim of vegetation-geography is characterizing, regionalizing and classifying dimensionally the territories of the earth, by means of characteristic vegetation units. The higher syntaxonomic categories of the plant communities, however, do not serve the purpose of constructing a dimensional hierarchy of vegetation. For this reason, author suggests the introduction of the term "vegetation-form". Vegetation-forms are characterized by means of synecological species-groups. The vegetation-forms are composed by mosaic elements of vegetation, named "micro-phytochors", which correspond to the subassociations or geographical races of associations. The aggregations of "meso-phytochors" and "macro-phytochors" lead to the formation of the higher vegetation-geographical dimension-levels.

Syntaxonomie und räumliche Vegetationsstruktur

Von besonderer Bedeutung für die Vegetationsgeographie erscheint die Frage nach der Widerspiegelung der geographischen Dimensionen durch die räumliche Vegetationsstruktur, wobei es vor allem auf die Kennzeichnung heterogener Naturraumeinheiten ankommt. Solche chorischen Vegetationslandschaften können nur als Vegetationsmosaike definiert werden, die sich aus homogenen topischen Teilarealen, den Grundeinheiten der vegetationsgeographischen Landschaftsgliederung, zusammensetzen (SCHLÜTER, 1975, 1979).

Da Syntaxonomie und räumliche Vegetationsstruktur von einander unabhängigen Gesetzmäßigkeiten folgen und damit völlig verschiedene Betrachtungsebenen darstellen, gibt es zwischen beiden Gliederungsprinzipien keine Übereinstimmung oder Parallelität. Höhere räumliche Aggregationsstufen können nicht durch entsprechend höhere syntaxonomische Kategorien wie Verband, Ordnung oder Klasse gekennzeichnet werden (vgl. SCHMITHÜSEN, 1963; DOING KRAFT, 1963). So kann eine vegetationsgeographische Dimensionshierarchie auch nicht aus der syntaxonomischen Hierarchie abgeleitet werden, wie dies SCHMITHÜSEN (1968) für seine »auf dem Gesellschaftsinventar begründeten natürlichen Vegetationsgebiete verschiedener Rangstufe« vorschlägt.

Vegetationsgeographische Elementareinheit

Das entscheidende Kriterium für Elementareinheiten jeder räumlichen Gliederung ist die Homogenität der für die Kennzeichnung verwendeten Merkmale. Das bedeutet für die Vegetationsgeographie, daß die räumlichen Elementareinheiten einen nach ihrer Artenzusammensetzung und -verteilung homogenen Pflanzenbestand aufweisen müssen, der nach dem floristisch-soziologischen Gliederungsprinzip an Hand der Artenkombination einem bestimmten Vegetationstyp zuzuordnen ist.

Vegetationsgeographische Elementareinheiten können nur durch arealrelevante Vegetationstypen gekennzeichnet werden, die einen eindeutigen Standortsbezug aufweisen. Dieser für die räumliche Betrachtung entscheidende Gesichtspunkt spielt jedoch bei der syntaxonomischen Ordnung der Vegetationseinheiten zunächst keine Rolle. Darum erscheint es notwendig, für die vegetationsgeographische Raumanalyse eine eigene Gliederung der Elementareinheiten nach Kriterien der Arealstruktur der Vegetation aufzustellen. Damit soll kein weiteres konkurrierendes Vegetationssystem, sondern eine ausschließlich arealorientierte, standortsbezogene Vegetationsgliederung geschaffen werden, die unabhängig von bestehenden pflanzensoziologischen Schulen auch alle vegetationskundlich arbeitenden praxisorientierten Richtungen — insbesondere die forstliche Standortserkundung — voll einzubeziehen gestattet.

Entscheidend ist allein die räumliche Repräsentanz des betreffenden Vegetationstyps, unabhängig von dessen ohnehin nicht immer eindeutigen syntaxonomischen Rang im Vegetationssystem. Es können daher nur solche Vegetationseinheiten für die vegetationsgeographische Naturraum- und Landschaftsgliederung herangezogen werden, die unter bestimmten Standortsbedingungen flächenhaft als Strukturelemente des Vegetationsmosaiks auftreten, das damit das Standortsmosaik widerspiegelt.

Extrazonale Vegetationstypen extremer Sonderstandorte, an denen ein kleinräumig stark variierender Ökofaktor dominiert oder ins Minimum gerät, bilden so eng verzahnte oder zonierte Vegetationskomplexe auf engem Raum, daß die einzelnen Vegetationseinheiten nicht als vegetationsgeographische Elementareinheiten verwendbar sind. Hier liegt aber auch insofern ein Sonderfall vor, als es sich um syngenetisch und synökologisch eng miteinander verbundene, meist von einander unmittelbar abhängige Gesellschaften handelt (SCHLÜTER, 1979). Das beste Beispiel stellen die Zonierungen und Verzahnungen im Xerothermkomplex mit Mantel- und Saumgesellschaften dar. Ihre Trennung ist ein rein syntaxonomisches Problem, während sie unter vegetationsgeographischem Aspekt im Sinne der »Steppenheide« (GRADMANN, 1950) zu einer Einheit zusammenzufassen sind (vgl. JAKUCS, 1972), wenn damit auch das Homogenitätsprinzip bei Elementareinheiten weder in vegetations-

kundlicher noch in ökologischer Hinsicht voll erfüllt ist. Solche Nanomosaiktypen lassen sich jedoch leicht nach synökologischen Kriterien zu einer vegetationsgeographischen Elementareinheit zusammenfassen.

Zur eindeutigen Unterscheidung gegenüber rein pflanzensoziologisch definierten syntaxonomischen Kategorien erscheint es zweckmäßig, für die arealbezogene vegetationsgeographische Elementareinheit einen eigenen, klar definierten Begriff zu prägen. In Übereinstimmung mit Termini aus Landschaftsökologie, Naturraumerkundung und forstlicher Standortskunde — wie Standortsform und Bodenform — bietet sich für den die topische Dimension kennzeichnenden Vegetationstyp (»Phytotop« HAASE, 1967) die Bezeichnung »Vegetationsform« an.[1] Sie könnte wie folgt definiert werden:

Eine Vegetationsform ist ein floristisch-soziologisch definierter Vegetationstyp, der sich in Koinzidenz zur entsprechenden Standortsform befindet und der mit seinem Areal als vegetationsgeographische Elementareinheit des landschaftlichen Vegetationsmosaiks einen Phytotop vegetationsökologisch kennzeichnet.

In der Vegetationsform werden alle floristisch-soziologisch und synökologisch sich nachstehenden oder als Synonyma mehrfach beschriebenen arealrelevanten Vegetationseinheiten bzw. Nanomosaiktypen zusammengefaßt. Bei ihrer Kartierung als ökologische Raumeinheiten stellt die Prüfung der (inhaltlichen) Konvergenz und der (räumlichen) Kongruenz zwischen Vegetationsform und Standortsform eine für die Naturraumerkundung und -kartierung entscheidende Frage dar.

Für die Ausscheidung und Charakterisierung der Vegetationsformen bieten sich »Ökologisch-soziologische Artengruppen« (SCHLÜTER, 1957) an, da sie die Auswertung der Artenkombination sowohl für die floristisch-soziologische Kennzeichnung des Vegetationstyps als auch für die Bewertung seiner standortsökologischen Bedingungen gestatten. Diese ursprünglich für die forstliche Standortserkundung und -kartierung erarbeitete Methode einer standortsökologisch ausgerichteten Vegetationsanalyse (SCHLÜTER, 1963) führt zu eindeutig definierten Elementareinheiten der vegetationsgeographischen Raumgliederung und erscheint darum für diese Fragestellung besonders geeignet. Als kürzere, prägnante Bezeichnung wird »Synökologische Artengruppe« vorgeschlagen.

Bei der vegetationsgeographischen Landschaftsgliederung sind neben standortsbedingten vor allem geographischen relevante Abwandlungen der Vegetationsformen zu beachten. Sie sind entsprechend den »Gebietsassoziationen« und »Geographischen Rassen« (OBERDORFER, 1968) anhand arealtypischer Änderungen in der Artenkombination bzw. nach chorologisch eindeutigen »Geographischen Trennarten« zu bestimmen.

[1] Herrn Dr. habil. D. KOPP, Eberswalde, der im Rahmen der forstlichen Standortserkundung zu entsprechenden Vorstellungen gekommen war, verdanke ich wertvolle Anregungen.

Standortsökologisch homologe Vegetationsreihen

Mit synanthropen Vegetationsformen im Sinne von Ersatzgesellschaften können wir nicht unmittelbar die für die Naturraumerkundung und -kartierung entscheidenden standortsökologisch gleichwertigen Flächen inhaltlich bestimmen und gegeneinander abgrenzen. Dies ist nur möglich, wenn es gelingt, standortsökologisch homologe Vegetationsformen verschiedenen Natürlichkeitsgrades zusammenzufassen und zu parallelisieren, d. h. Reihen der unter gleichen primären Standortsbedingungen vorkommenden und damit standortsökologisch homologen Wald-, Forst-, Grünland- und Acker-Vegetationsformen aufzustellen (vgl. SCHLÜTER, 1979).

Die Konzeption des »Gesellschaftsrings« (SCHWICKERATH, 1954), die SCHMITHÜSEN (1968) der vegetationsgeographischen Raumgliederung zugrunde legt, erfüllt nicht die Forderung nach einer eindeutigen Koinzidenz zwischen Vegetationseinheit und Standortseinheit. Es werden primäre, mit einem Standortswandel verknüpfte Sukzessionsreihen einbezogen, und bei den sekundären Sukzessionsfolgen werden vielfach standortsökologisch sowie syntaxonomisch und damit als vegetationsgeographische Elementareinheit nicht gleichwertige Reihen mit verschiedenen Endstadien der potentiell-natürlichen Vegetation zu einem Gesellschaftsring vereint (SEIBERT, 1968). Auch suggeriert das Bild eines Ringes die völlig falsche Vorstellung einer generellen Identität zwischen natürlicher Ausgangsgesellschaft und der potentiell-natürlichen Schlußgesellschaft (SCAMONI, 1963), womit die entscheidende theoretisch-methodische Grundlage der potentiell-natürlichen Vegetation (TÜXEN, 1956) völlig ignoriert wird.

Bei synanthropen Ersatzgesellschaften ist der anthropogene Einfluß Teil der Lebensbedingungen, und für diesen Standortsfaktor hat die Ersatzgesellschaft einen eindeutigen Indikatorwert. Ihr Zeigerwert gegenüber den primären natürlichen Standortsfaktoren hängt vom Vorhandensein spontan entstandener standortsspezifischer Artenkombinationen als Kriterium des Natürlichkeitsgrades ab.

Die theoretisch am besten fundierte Bezugsbasis für die standortsökologisch homologen Vegetationsreihen stellt die potentiell-natürliche Vegetation im Sinne von TÜXEN (1956) dar. Sie kennzeichnet als diejenige natürliche Vegetation, die den heutigen, vielfach mehr oder weniger anthropogen veränderten Standortsbedingungen entspricht, das räumliche, standortsbedingte Vegetationsgefüge der Landschaft. Die potentiell-natürliche Vegetationsform steht gleichsam als Symbol für die Gesamtheit der mit ihr genetisch verbundenen synanthropen Ersatzvegetationsformen als mögliche oder reale Vegetation des Phytotops.

Je geringe der Natürlichkeitsgrad einer Vegetationsform ist, um so größer wird das Problem, diese dann oft rein hypothetische potentiell-natür-

liche Vegetation mit ausreichender Sicherheit objektiv zu ermitteln. Wir brauchen aber zumindest klare Vorstellungen ihrer Struktur und Diversität, denn erst die Verbindung und vergleichende Auswertung der real-aktuellen und der potentiell-natürlichen Vegetationsformen ermöglicht die vegetationsökologische Kennzeichnung und Bewertung des Vegetationsgebietes im Hinblick auf den Natürlichkeitsgrad und die optimale Diversität als Grundlage der Landschaftsplanung (SCHLÜTER, 1980).

Zur Mosaikstruktur heterogener Vegetationsgebiete

Die im Sinne von »Synassoziationen« in homologen Vegetationsreihen parallelisierten Vegetationsformen (SCHLÜTER, 1979) bieten als vegetationsgeographische Elementareinheiten die Grundlage für die Kennzeichnung, Typisierung und Kartierung landschaftlicher Vegetationsmosaike sowohl nach ihrer Inhaltsstruktur als auch nach der Arealstruktur. Nur so ist das innere Gefüge des Vegetationsmosaiks als wesentliches Merkmal einer heterogenen oder zusammengesetzten Raumeinheit erfaßbar, im Gegensatz zum Vegetationskomplex (TÜXEN, 1956, SEIBERT, 1968), der allein das Inventar eines Gebietes an Vegetationseinheiten — unabhängig von Natürlichkeitsgrad und Arealrelevanz — beinhaltet. Dieser Unterschied zwischen dem arealorientierten Vegetationsmosaik und dem inhaltsorientierten Vegetationskomplex sollte im Sinne einer scharfen Trennung zwischen Arealstruktur und Inhaltsstruktur unbedingt beachtet werden.

Die sich aus der Vergesellschaftung von zu homologen Reihen zusammengefaßten Vegetationsformen ergebenden Vegetationsmosaike lassen sich nach ihrer Inhalts- und Arealstruktur an Hand von Leit- und Begleit-Vegetationsformen sowie nach Gefügemerkmalen kennzeichnen und typisieren. Sie charakterisieren die untersten Einheiten der naturräumlichen Dimensionshierarchie (NEEF, 1963) — insbes. die Mikrochoren —, die im Rahmen der Vegetationsgeographie als Mikro-Phytochoren bezeichnet werden sollten. Diese Mosaiktypen werden nach möglichst nur einer Leitvegetationsform benannt, die unabhängig vom syntaxonomischen Rang allein nach ihrer arealkennzeichnenden Bedeutung festzulegen ist; es kann sich also ohne weiteres um eine Subassoziation oder geographische Rasse handeln.

Die vegetationsgeographische Kennzeichnung höherer Dimensionsstufen muß allein nach der höheren räumlichen Aggregationsstufe der Vegetation erfolgen, d. h. im Sinne einer dimensionsspezifischen Merkmalswahl (HERZ, 1973) nach der Vergesellschaftung der Leitvegetationsformen der sie zusammensetzenden Mikro-Phytochoren. Für die Ebene der Meso-Phytochoren könnten sich Gebiets- oder Regionalassoziationen als Leitvegetationsformen anbieten. Deren Vergesellschaftung führt dann zu den Makro-Phytochoren,

die durch entsprechend höher aggregierte Leitvegetationsformen zu kennzeichnen sind.

Erst beim Übergang zur regionischen Dimension werden als dimensionsspezifisches Merkmal höhere syntaxonomische Einheiten als Leitvegetationsformen heranzuziehen sein, die dann bereits Unterschiede im Formationscharakter der Vegetationsregionen widerspiegeln. Damit wäre der Anschluß an eine globale Gliederung in Biome (WALTER, 1976) zu erreichen, ohne das arealorientierte Prinzip der Mosaikbetrachtung zu verlassen.

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POTENTIELLE VEGETATIONSKARTE DER DONAUSTRECKE ZWISCHEN RAJKA UND NAGYMAROS

Von

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The authors are publishing the potential vegetation map of the Hungarian section of the Danube — flood plain between Rajka and Nagymaros. This work became actual in connection with the establishing of the Gabčikovo—Nagymaros-barrage system and has been done in order to be able to predict — with the knowledge of the potential vegetation and its dynamic processes — the expectable changes to be taking place parallel to the changes of the average water surface.

In the first part of this work the authors present the potential vegetation map and the mapped vegetation units — together with their short description, in the second part they give an estimation of the expectable change of the ecological conditions, that is they state, into what type the present vegetation (willow-poplar grove, esh-elm-oak grove etc.) will turn as a result of the rising or sinking of the water surface.

Der Lehrstuhl für Pflanzensystematik und Ökologie der Loránd Eötvös-Universität befaßte sich — im Rahmen eines Auftrags — mit der Untersuchung der zu erwartenden Umweltsänderungen, die im Zusammenhang mit dem zwischen Gabtschikovo und Nagymaros zu errichtenden Kraftstufensystem auftreten mögen, und dies vor allem vom Gesichtspunkt der Biologie und des Umweltschutzes. Für unsere Arbeit stand uns die Vegetationsperiode des Jahres 1976 zur Verfügung. Wir befaßten uns mit der Flutraumvegetation des Flußabschnitts zwischen der Landesgrenze und Nagymaros, an gewissen Stellen auch die benachbarten, vom Wasserstand weniger beeinflußten Gebiete berücksichtigend. Aufgrund früherer literarischer Quellen und unserer eigenen Erfahrungen haben wir die Richtungen der biotischen Sukzession festgestellt, und aufgrund dieser und der Ermessung der gegenwärtigen Vegetation auch die potentielle Vegetationskarte des Gebiets im Maßstab von 1 : 50 000 verfertigt. Wir haben die Tendenz der in Kenntnis der Sukzessionsänderungen zu erwartenden Umgestaltungen, in den Zusammenhängen von Grundgestein und Klima die wasserwirtschaftliche Lage der Bodendecke und ihre Änderungstendenzen, sowie den gegenwärtigen Zustand der Fischfauna und ihre voraussichtliche Umgestaltung abgeschätzt.

Mit Rücksicht darauf, daß die Vegetation und die einzelnen Pflanzenassoziationen sich — infolge der im Zusammenhang mit dem Bauobjekt eintretenden Änderungen in den Wasserverhältnissen des Flußbettes und der Überschwemmungsgebiete —, der neuen Lage entsprechend, ändern werden, erwiesen sich zwei Aufgaben als entscheidend: 1. Verfertigung einer potentiellen Vegetationskarte, 2. Abschätzung der sukzessiven Umgestaltung der gegenwärtigen Vegetation aufgrund der bisherigen Erfahrungen und Untersuchungen.

Diese ökologische Prognostik ist auf dem gegebenen Gebiet in der Kenntnis der räumlichen Verteilung der ungestörten und entwicklungsfähigen — potentiellen — Vegetation möglich. Darum haben wir in unserer Arbeit zuerst die Abschätzung, sodann die Kartierung der

potentiellen Vegetation durchgeführt. Aufgrund der Kenntnis der bereits bekannten Vegetationsentwicklungsverhältnisse und -tendenzen, sowie mit Berücksichtigung der zu erwartenden Änderungen des Wasserstandes kann der Charakter, die Richtung und das Maß der Umweltsänderung verläßlich abgeschätzt werden.

Die potentielle Vegetationskarte und ihre Erklärung

Die beigefügte Vegetationskarte wurde in zwei Etappen verfertigt. Zuerst haben wir auf die Grundkartenblätter im Maßstab von 1 : 10 000 (vereinbarter Plan des Gabtschikovo—Nagymaros-Kraftstufensystems) — aufgrund lokaler Begehungen — die Vegetation (bzw. ihre Standorte) eingetragen, später wurden diese mittels Luftaufnahmen von 1 : 10 000 kontrolliert, bzw. korrigiert. In der zweiten Etappe wurde die auf diese Weise verfertigte Grundkarte auf eine Größe von 1 : 50 000 verkleinert.

Kartenerklärung

1. *Die unter Wasser gesetzte Gebiete nach dem Aufbau des Kraftstufensysteems*

Diese wurden auf der Karte mit Hilfe einer rechts steigenden, schrägen Schraffierung bezeichnet. Neben der Schraffierung ist auch die Bezeichnung (2, 3, usw.) der heutigen potentiellen Vegetation des gegebenen, in Zukunft überfluteten Gebiets angegeben! Die neue, zukünftige Vegetation kann aufgrund des Maßes der Überflutung abgeschätzt werden (s. noch Abb. 2).

Auwälder

Sie zeigen auf der potentiellen Vegetationskarte große Flächen. Diese Vegetation ist auf den niedrigen Überschwemmungsgebieten durch Weiden-Pappel- (»Weichholz-«) Auen und auf den höheren Überschwemmungsgebieten durch Ulmen-Eschen-Eichen- (»Hartholz-«) Auen repräsentiert, aber die Ulmen-Eschen-Eichenauen zeigen nunmehr nur einige Reliktbestände (z. B. längs des Mosonyer Donauarmes). Auf dem Terrain dieser letzteren sind vor allem landwirtschaftliche Gebiete und Siedlungen vorzufinden.

2. *Weichholz-Auenwälder der niedrigen Übeschwemmungsgebiete*

Die Vegetation dieser Fluträume entwickelt sich unter natürlichen Umständen — in Intervallen von Jahrzehnten oder Jahrhunderten — von den Laichkrautassoziationen durch die offenen Aurasen bis zu den Weiden-Pappelwaldbeständen (das beste Beispiel bietet dafür der größte Teil des Szigetköz, diese letzteren bilden also die potentielle Vegetation!).

Diesen Prozeß widerspiegelnd zeigen die Vertiefungen des Flutraumes (verlassene Flußbette, tote Arme) — in der zunehmenden Distanz von dem lebenden Bett — ein sowohl in Hinsicht auf die Bodenentwicklung, wie auch auf die Vegetationsentwicklung (Sukzession) immer fortgeschritteneres Bild. Die charakteristische potentielle Pflanzengesellschaft der Terrassenränder und der jungen Vertiefungen ist die Weiden-Pappelau (*Salicetum albae-fragilis*). Ihre Laubkronenschicht erreicht in ihrem entwickelten Stadium 15—25 m, *Salix alba* und *Populus nigra* sind in ihr vorherrschend, charakteristische Kriechpflanzen sind *Humulus lupulus*, *Echinocystis lobata* und *Calystegia sepium*. In ihrer Strauchschicht kommen Holundersträucher, *Cornus sanguinea*, in der Rasenschicht *Polygonum*-Arten, *Urtica dioica* und *Rubus caesius* häufig vor. Letztere Art bildet am häufigsten den Waldtypus und sie zeigt einen frischen Boden mit guter Wasserversorgung an. Ihre Bestände wachsen im allgemeinen auf mineralhaltigen Ablagerungen und entwickeln sich im Laufe der weiteren — alluvialen — Aufschüttung in *Populus nigra*-, *P. alba*-, *P. canescens*- und *Cornus sanguinea*-Strauchschichten zeigende Bestände.

3. *Hartholz-Auenwälder des höheren Überschwemmungsgebiets*

Auf den höheren Terrains des Überschwemmungsgebiets, auf den altholozänen und hohen jungholozänen Terrassen entstehen potentiell die verschiedenen Typen der sog. Hartholz-Auenwälder (anders genannt Ulmen-Eschen-Eichenauenwälder — *Fraxino pannonicae-Ulmetum*). Diese Wälder werden nur sehr selten, zur Zeit des höchsten Wasserstandes vom Fluß überflutet, und auch dann nur für kurze Zeit, ihre Bodenstruktur ist deshalb gegliedert und auch ein humushaltiger oberer Horizont mag entstehen. In dieser oberen Schicht, deren Mächtigkeit im allgemeinen 30—40 cm beträgt, kann der Humusgehalt 3% übertreffen. Die ständige Wasserbewegung kann eine größere Menge von Humusstoffen auch in die tiefer liegenden Bodenschichten abspülen, besonders auf sandigen Böden. So kommt manchmal auch in 2 m Tiefe mehr als 1—2 Prozent Humus vor.

Die Schwankung des Grundwasserspiegels ist durch die Gleybildung des Profils angezeigt, die zeitweilige Senkung des Wassers bringt Rostadern hervor. Die Wasserwirtschaft dieser Standorte zeigt innerhalb der Waldgesellschaft feinere Unterschiede — vom nassen durch frische bis zum mesophilen —, was von der Vegetation der Rasenschicht (Waldtypus), aber öfters auch von der Zusammensetzung der Laubkronenschicht angedeutet wird.

Da die Donau ihre Ablagerungen größtenteils von Gebieten mit basischem Gestein transportiert, ist der Boden der längs der Donau befindlichen Hartholzauen ausdrücklich basisch. Der pH-Wert ist am häufigsten 8,8—5, obwohl in der oberen Bodenschicht eine schwache Azidität nachzuweisen ist. Damit stimmt jene Beobachtung überein, daß der $CaCO_3$-Gehalt des Bodens

nach unten stufenweise zunimmt. Der Kalkgehalt des Bodens der Hartholzauen schwankt stark je nach Standort, es können Werte zwischen 14—40% gemessen werden.

Die Hartholzauen der hohen Überschwemmungsgebiete besitzen reiche Strauchschichten und haben meistens doppelte Laubkronenschichten. In der oberen Laubkronenschicht kommen am häufigsten Stieleichen (*Quercus robur*) vor, die von der ungarischen Esche (*Fraxinus angustifolia* ssp. *pannonica*) und der Feldulme (*Ulmus minor*) begleitet werden. An manchen Stellen erreichen *Ulmus laevis*, die Silberpappel (*Populus alba*) und auch *Prunus padus* die obere Laubkronenschicht. An den tiefer liegenden Standorten können sich der oberen Laubkronenschicht auch *Salix alba* und Silberpappeln (*Populus nigra*) beimischen. In der unteren Laubkronenschicht sind Eichen, Ulmen, Feldahorne (*Acer campestre*) und manchmal Hainbuchen (*Carpinus betulus*) vorzufinden. An einigen Standorten treten vereinzelt auch Holzapfelbäume (*Malus pumila*) und Kirschbäume (*Prunus avium*) auf.

Die Artenzusammensetzung und Deckung der Strauchschicht kann je nach Waldtypen verschieden sein. Die Höhe der Strauchschicht beträgt 2,5—4 m, ihre Deckung mag auch 90% erreichen. Infolge des Waldbaus werden die Sträucher regelmäßig gerodet und da der Großteil der ungarischen Hartholzauen aus bebauten Wäldern besteht, ist es schwer über die potentielle Strauchbedeckung zahlenmäßige Werte anzugeben. Die kennzeichnendste Straucharten sind: *Cornus sanguinea, Viburnum opulus, Crataegus monogyna, Acer tataricum, Ligustrum vulgare, Euonymus europaeus, Corylus avellana* und *Frangula alnus.*

Die Deckung der Rasenschicht ändert sich von der Deckung der Strauchschicht abhängend, und zwar in entgegengesetzter Richtung als diese letztere. Für die Hartholzauen sind vor allem einige Seggenarten charakteristisch: *Carex remota, C. divulsa, C. brizoides, C. silvatica* und *C. vulpina.* Außer den Seggenarten ist *Barbarea stricta* allgemein verbreitet und auch *Aegopodium podagraria,* sowie *Circaea lutetiana* kommen häufig vor. In den einzelnen Typen können *Ficaria verna, Scilla bifolia, Galanthus nivalis, Viola cyanea, Convallaria majalis* und *Polygonatum latifolium* häufig, sogar massenhaft auftreten.

Auf den durch Kulturwirkungen stark beeinflußten Gebieten herrschen *Urtica dioica, Galium aparine* und *Chaerophyllum bulbosum* vor. Diese Arten kommen in sämtlichen Beständen vereinzelt vor, spielen aber in den ungestörten Beständen keine bedeutende Rolle.

In den Ulmen-Eschen-Eichenauenwäldern längs der Donau sind in bedeutender Zahl solche Elemente vorzufinden, die für die Eichen-Hainbuchen- und Buchenwälder charakteristisch sind. Einige solche Arten sind: *Sanicula europaea, Heracleum sphondylium, Asperula odorata, Festuca gigantea, Majanthemum bifolium, Arum maculatum, Epipactis helleborine, Polygona-*

tum latifolium, Pulmonaria officinalis, Symphytum tuberosum, Campanula trachelium, Paris quadrifolia, Impatiens noli-tangere, Corydalis bulbosa, Viola silvestris, usw.

In den Ulmen-Eschen-Eichenauenwäldern erschienen als Ergebnis anthropogener Einwirkungen zahlreiche hineingeschleppte Pflanzenarten. Solche sind z. B.: *Amorpha fruticosa, Acer negundo, Solidago gigantea, Erigeron canadensis, Asclepias syriaca,* usw. Die völlige Verpappelung der Auenwälder infolge der Kahlschläge bedeutet eine ernste Sorge.

Vegetation der Sand- und Lößrücken

Auf der potentiellen Vegetationskarte kommen die hierher gehörenden Typen in verhältnismäßig kleinen Flecken vor. In der Wirklichkeit ist ihre Ausdehnung noch kleiner, da auf den von ihnen eingenommenen Gebieten größtenteils solche Waldbestände zu finden sind, die als Ergebnis des landwirtschaftlichen Anbaus — öfters in großbetrieblichem Maße —, oder infolge einer Aufforstung durch Baumarten entstanden sind. Demzufolge treten die natürlichen Elemente in der Vegetation stark in den Hintergrund, oder sie verschwinden sogar völlig.

4. *Maiglöckchenreiche Eichenwälder*

Über den unteren Überschwemmungsgebieten — den Weichholz- und Hartholzauen — mit sandigem, schotterigem Untergrund herrschte auf den höheren, hochwasserfreien Terrains (ung. 8—10 m über der durchschnittlichen Wasserstandshöhe) die einstige natürliche Vegetation, die Waldsteppe vor, die mit Lichtungen untermischten niedrigen Waldbeständen wechselte. Die dominante Baumart mag die Stieleiche gewesen sein, ähnlich wie in dem Donau—Theiß-Zwischenstromland. Diese kommen heute nur in sporadischen Fragmenten in der Umgebung der Donau vor, besonders in der Nähe von Ács und Győrszentiván. In diesen fragmentarischen Beständen ist der Unterwuchs stark verfallen, seine Artenzahl nahm ab und infolge der Robinienpflanzungen vermehrten sich in ihr viele nitrophile Unkrautarten.

Einige alte Bäume der einstigen Stieleichenwälder bilden ein auch landschaftlich auffallendes Relikt in dem Wald von Ács, ein Teil dessen unter Naturschutz steht. Seine Berühmtheit ist das Vorkommen der Art *Eranthis hiemalis.*

Auf den zönologisch als maiglöckchenreiche Eichenwälder gewerteten (*Convallario-Quercetum*), verhältnismäßig frische Böden zeigenden Sandgebieten mag aber auch eine bereits kleine Höhendifferenz (Grundwassersenkung von 50—70 cm) genug sein, um dort eine lokale, edaphische Sandsteppenrasen-

Vegetation entstehen zu lassen. Diese ursprünglichen Steppenflecke bewahrten jene Sandsteppenarten, die auch heute noch vorzufinden sind, öfters an Stelle der einstigen Wälder, auf einem vielleicht ausgedehnteren Gebiet als das ursprüngliche war.

5. *Sand- und Lößwaldsteppe*

Eine kennzeichnende rasenbildende Pflanze der Sandsteppenvegetation ist *Festuca vaginata*, die Assoziationen bildet und einige seltene und an der Arealgrenze befindliche, interessante Reliktarten aufweist. Eine solche Art ist z. B. *Dianthus arenarius*.

Im heutigen Zustand ist es sehr schwer, meistens sogar unmöglich, die Grenzen der einstigen ursprünglichen Steppenflecke und Waldgebiete festzustellen. Darum betrachteten — und bezeichneten — wir auf der potentiellen Vegetationskarte an diesen Stellen den maiglöckchenreichen Eichenwald als das höchst organisierte Stadium (Pflanzengesellschaft), zu welchem auf diese Weise auch das größere-kleinere Mosaikkomplex der Steppenvegetation gehört.

Der Sandsteppenvegetation fällt im Donautal im Raum von Pilismarót, Esztergom, Győrszentiván und Komárom eine bedeutendere Rolle zu, sie drängt ganz bis in die Umgebung von Tatabánya und bis zur Grenzlinie der Kleinen Ungarischen Tiefebene und des Bakony-Gebirges ein (z. B. Kiefern-Sandsteppenrelikt in der Gegend von Fenyőfő).

Auf den Gebieten mit einer Lößdecke verschwand die ursprüngliche Vegetationsdecke in noch höherem Maße. Längs der Donau sind die von Löß bedeckten Gebiete noch unbedeutender als die Sandgebiete. Die Lößdecke des Gerecse-Pediments und die Randgebiete des Visegráder Gebirges sind vor allem wichtig. Ihr Großteil steht seit Jahrhunderten unter landwirtschaftlicher Bebauung, so geben uns nur die an den Grenzrainen wachsenden Arten Informationen über das einstige, höher entwickelte Bild der Lößsteppenvegetation. Heute weisen auf diese nur die Lößhohlwege und die schmalen Kluftränder hin (z. B. in der Umgebung von Dunaalmás und Neszmély).

Wegen der starken Verringerung der Lößgebiete sind ihre Reliktflecke vom Gesichtspunkt der Analyse der einstigen Vegetation höchst wichtig, auch sind sie in Hinsicht auf den Naturschutz äußerst bedeutend. Die landwirtschaftlichen Kulturen verbreiteten sich am weitesten in Lößgebieten, so wurden die Elemente der Vegetationsdecke nur auf die für den Anbau weniger geeigneten, geomorphologisch gegliederten Terrains hinübergerettet.

Längs der Donau konnten sich auf den sanft abfallenden Pedimentgebieten vor allem Tatarenahorn-Lößeichenwälder (*Aceri tatarici-Quercetum*) herausbilden. Mosaikartig entstanden zwischen diesen rasenartige Steppenvegetation bewahrende, edaphische, baumfreie Gebiete. Ihre heutigen Bestän-

de befinden sich so hoch über der Grundwasserhöhe, daß diese keinen Einfluß auf die Vegetation ausübt. Nur die Steppenvegetation des ständig abbröckelnden Randes der einschneidenden Wasserrisse, sowie infolge der — in ihrem Grund aufgeschlossenen — undurchlässigen Schichten hier angesammelten Sickerwasser, oder periodische Schauerbäche zeigen innerhalb kleiner Gebiete große Gegensätze. Der im Grund der engen Wasserrisse öfters kennzeichnend erscheinende, schmale Weidenstreifen wurde wegen seiner kleinen Ausdehnung auf der Karte nicht angegeben.

Vegetation der Berghänge

Es wurden hierher die im östlichen Teil des kartierten Gebiets, an den zwei Seiten der Nagymaros-Visegráder Schlucht, auf den südlichen, bzw. nördlichen Hängen befindlichen xerothermen und mesothermen Assoziationen eingeordnet.

6. *Xerotherme Eichenwälder*

Ihr Vorkommen beschränkt sich auf die steilen S-, SW- Hänge des großen Donaubogens von Nagymaros, sie grenzen unmittelbar an die im schmalen Streifen entwickelten Weidenwälder, bzw. Hartholzwälder. Den morphologischen Verhältnissen, besonders der Exposition des Terrains entsprechend sind auf den sanfter fallenden Teilen der Eichen-Zerreichenwald, an den Standorten mit felsigen Böden der Flaumeichen-Zerreichenwald, sowie der Buschwald die wichtigsten Pflanzenassoziationen.

7. *Buchen- und Eichen-Hainbuchenwald*

Er kommt in größerer Ausdehnung in dem Gebiet des bereits erwähnten Donaubogens, am rechten Ufer, als ein extremer Gegensatz zu den südlich exponierten xerothermen Eichenwäldern des linken Ufers vor. Der gegenwärtige und der zu erwartende Wasserstand übt keinen unmittelbaren Einfluß auf diese letzteren zwei Formationen aus.

Die zu erwartenden Änderungen der potentiellen Vegetation

Über die zu erwartenden Wasserstandsänderungen des Bettes — im Verhältnis zu dem jetzigen durchschnittlichen Wasserstand — gibt das Längenprofil Informationen (Abb. 1). Es zeigt den zu erwartenden — im Verhältnis zum heutigen viel ausgeglicheneren — durchschnittlichen Wasserstand an. Den neuen Wasserstandsverhältnissen entsprechend wird — auch infolge der

langsamer werdenden Wasserbewegungen in den große Flächen zeigenden und tieferen Speichern — die Verbreitung des schwimmenden und wurzeligen Laichkrautes möglich. Die Weichholzauen längs des Flußes (Weiden-Pappelauen) übersiedeln parallel zu der durchschnittlichen Erhöhung der Wasserspiegellage auf das Überschwemmungsniveau der ursprünglichen Hartholzauen, zusammen mit den Weidenbüschen. Die früheren Hartholzauen (Ulmen-Eschen-Eichenau) des hohen Überschwemmungsgebiets werden auf die höheren Terrains verdrängt, oder sie verschwinden — von den Reliefsverhältnissen abhängend — völlig. Dieser Prozeß geht im Falle der Abnahme des Wasserstandes in entgegengesetzter Richtung vor sich, an Stelle der ursprünglich für das niedere Überschwemmungsniveau charakteristischen Weiden-Pappelbestände entstehen Standorte, die für die Entwicklung von weniger wasserbeanspruchenden Hartholzauen geeignet sind. Infolge einer stärkeren Abnahme des Wasserstandes kann sich auch eine für die Waldsteppe günstige Lage entwickeln. Auf den Waldgebieten muß dementsprechend mit Hilfe eines Artentausches die in etwa 40—50 Jahren stattfindende natürliche Sukzession beschleunigt werden.

Vom Gesichtspunkt des Umweltschutzes — der zugleich auch in ästhetischer Hinsicht bedeutend ist — soll in den Erholungsabschnitten der Donau, an den früher trockeneren Standorten die charakteristische Donaulandschaft mittels Aufforstung und an den Ufern mit Hilfe der Herausbildung von Weidenwäldern und Weidenbüschen gesichert werden.

In dem Inundationsgebiet der zukünftigen Speicher muß das organische Material — mit eingerechnet auch die humushaltigen Schichten — völlig entfernt werden. Wenn diese Aktion wegbliebe, würden die im Falle des Reservoirs der Stufe Tisza II erfahrenen Schädigungen der Wasserqualität unvermeidlich eintreten (Dévai, 1972).

Die den Wasserstandsverhältnissen entsprechend entwickelte natürliche Vegetation wird sich — dem neuen Wasserstand entsprechend — in der Richtung der trockeneren oder feuchteren Verhältnisse verschieben. Die Änderung der Lage der im Laufe der Abschätzung der natürlichen Vegetation festgestellten Typen können unter den neuen Verhältnissen durch die vertikale Wegrückung des rechten Teiles der Tabelle analysiert werden.

Mit Berücksichtigung der internationalen Erfahrungen (z. B. Bykow und Wasnow, 1971; Dévai, 1972; Felföldy, 1974; Rinaldi, 1978; Cox et al., 1976) kann festgestellt werden, daß man sich mit den Problemen der biologischen Wasserqualität und des Umweltseinflusses bereits im Frühstadium der Planung viel eingehender befassen sollte. Es muß jedoch zugegeben werden, daß die Erkennung des Wesens der Probleme, die Notwendigkeit, bzw. Dringlichkeit der »ökologischen Verschärfung« auf der ganzen Welt nur vor einigen Jahren dermaßen klargelegt wurde, wie sie jetzt vor uns steht. Von den sich mit der Planung und dem Bau von Speichern befassenden Lehr- und

Handbüchern, oder den biologisch hervorragenden limnologischen Arbeiten und mehrere Tausende ausmachenden Fachartikeln befassen sich nur wenige mit der Wirkung der erwähnten technischen Bauobjekte auf die Umwelt, bzw. mit der Analyse dieser Wirkungen. All dies macht es notwendig und betont, daß die Ermessung des ökologischen Gleichgewichtes im Zusammenhang mit dem Aufbau des Gabtschikovo—Nagymaros-Kraftstufensystems unerläßlich ist. Eine solche Ermessung umfaßt die Abschätzung, Prognostik des gegenwärtigen biozönotischen Bildes (Flora, Fauna, abbauende Organismen: Bakterien, Pilze, Lebewesen von mikroskopischer Größe) und die Feststellung der durch die unmittelbare oder mittelbare Wirkung der physischen Bedingungen hervorgerufene Änderungsrichtung dieses Bildes. Das wird durch zahlreiche Erfahrungen des Wolga-Speichersystems (Popow, 1969; Bykow und Wasnow, 1971) unterstützt, laut deren das grundlegende Ziel solcher Ermessungen die ökologische Untersuchung der biologischen Sukzession sein sollte. Auch unsere Untersuchungen zielten darauf hin.

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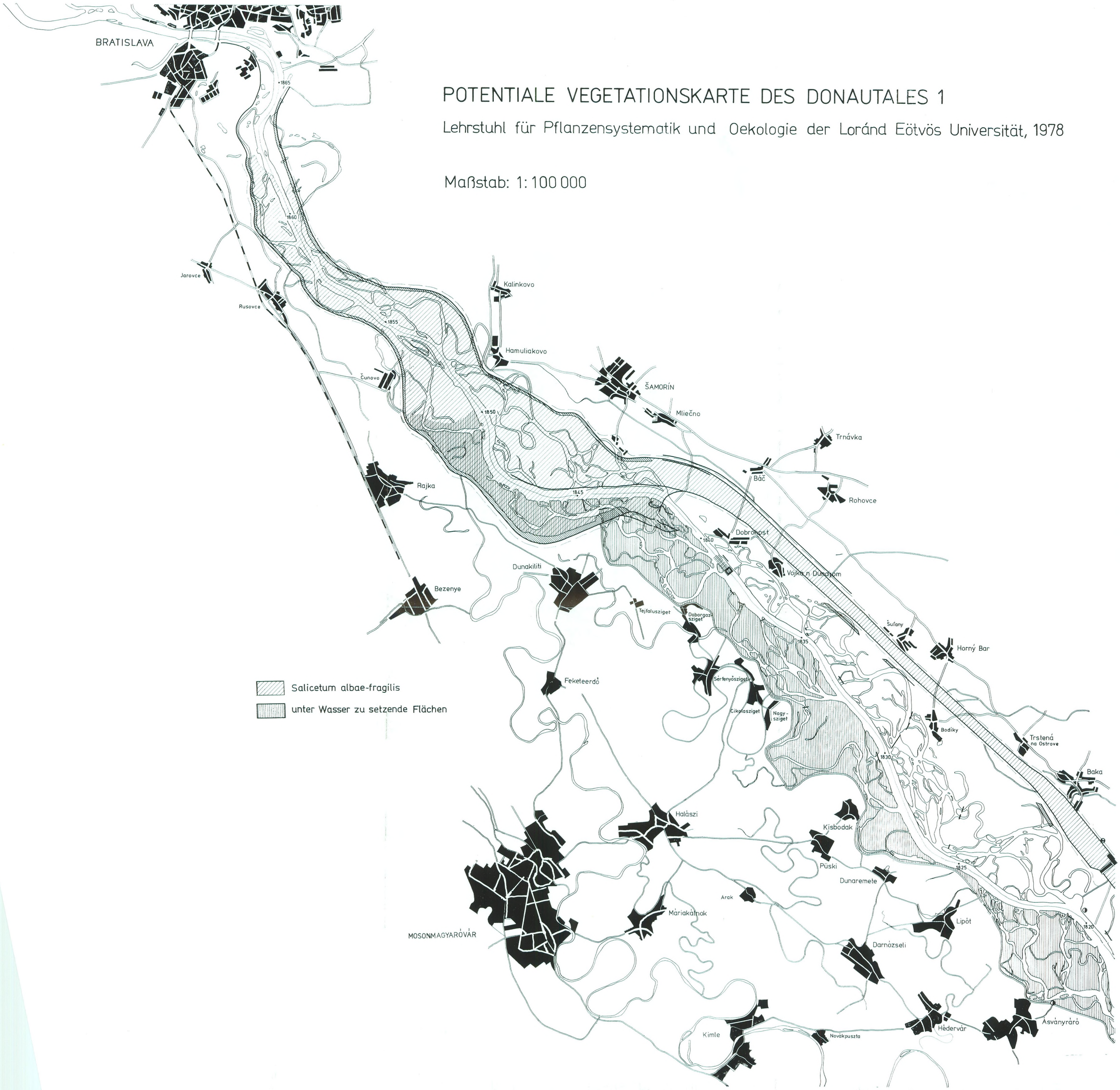
POTENTIALE VEGETATIONSKARTE DES DONAUTALES 1

Lehrstuhl für Pflanzensystematik und Oekologie der Loránd Eötvös Universität, 1978

Maßstab: 1: 100 000



POTENTIALE VEGETATIONSKARTE DES DONAUTALES 2

Lehrstuhl für Pflanzensystematik und Oekologie der Loránd Eötvös Universität, 1978

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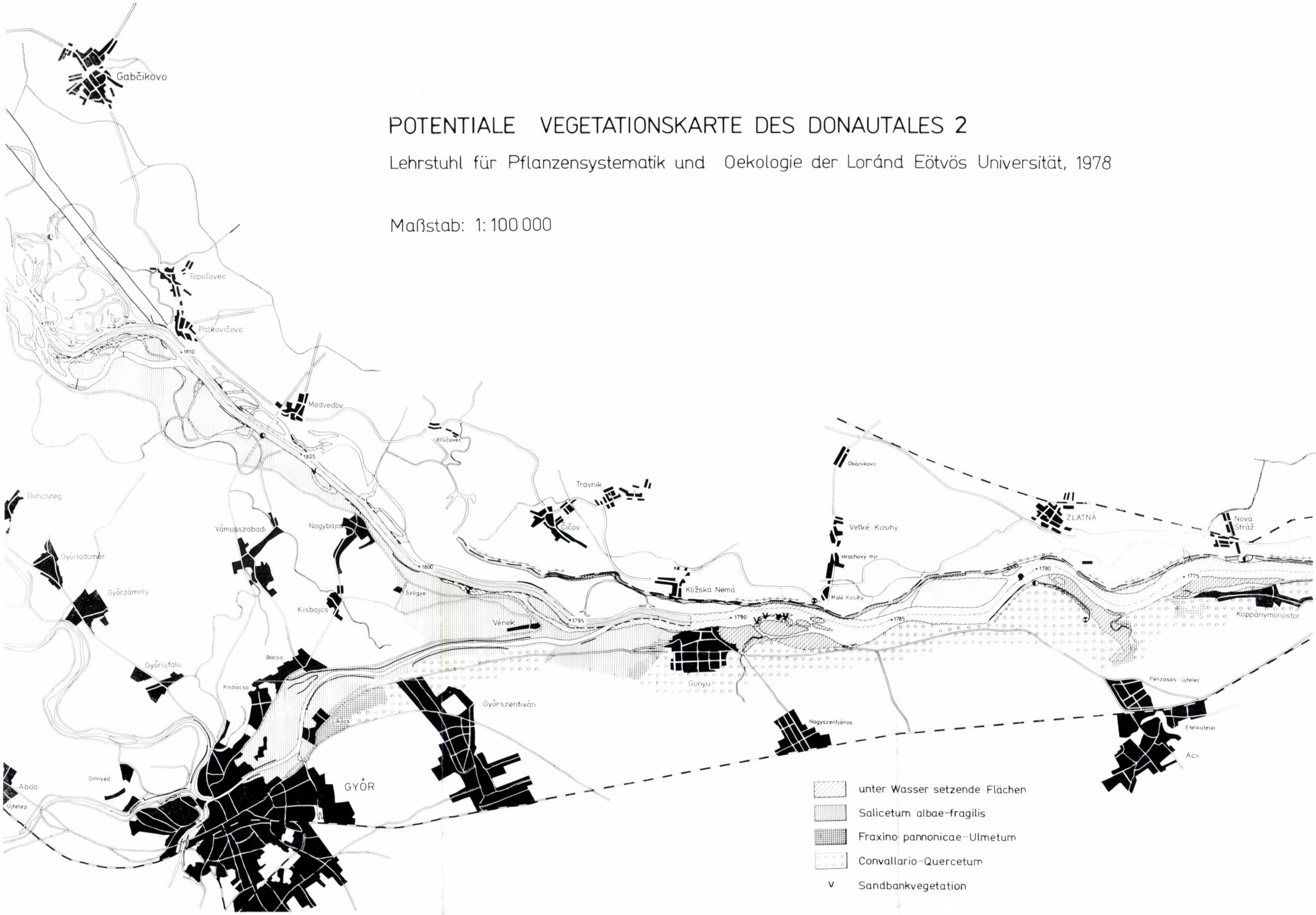

POTENTIALE VEGETATIONSKARTE DES DONAUTALES 4

Lehrstuhl für Pflanzensystematik und Oekologie der Loránd Eötvös Universität, 1978

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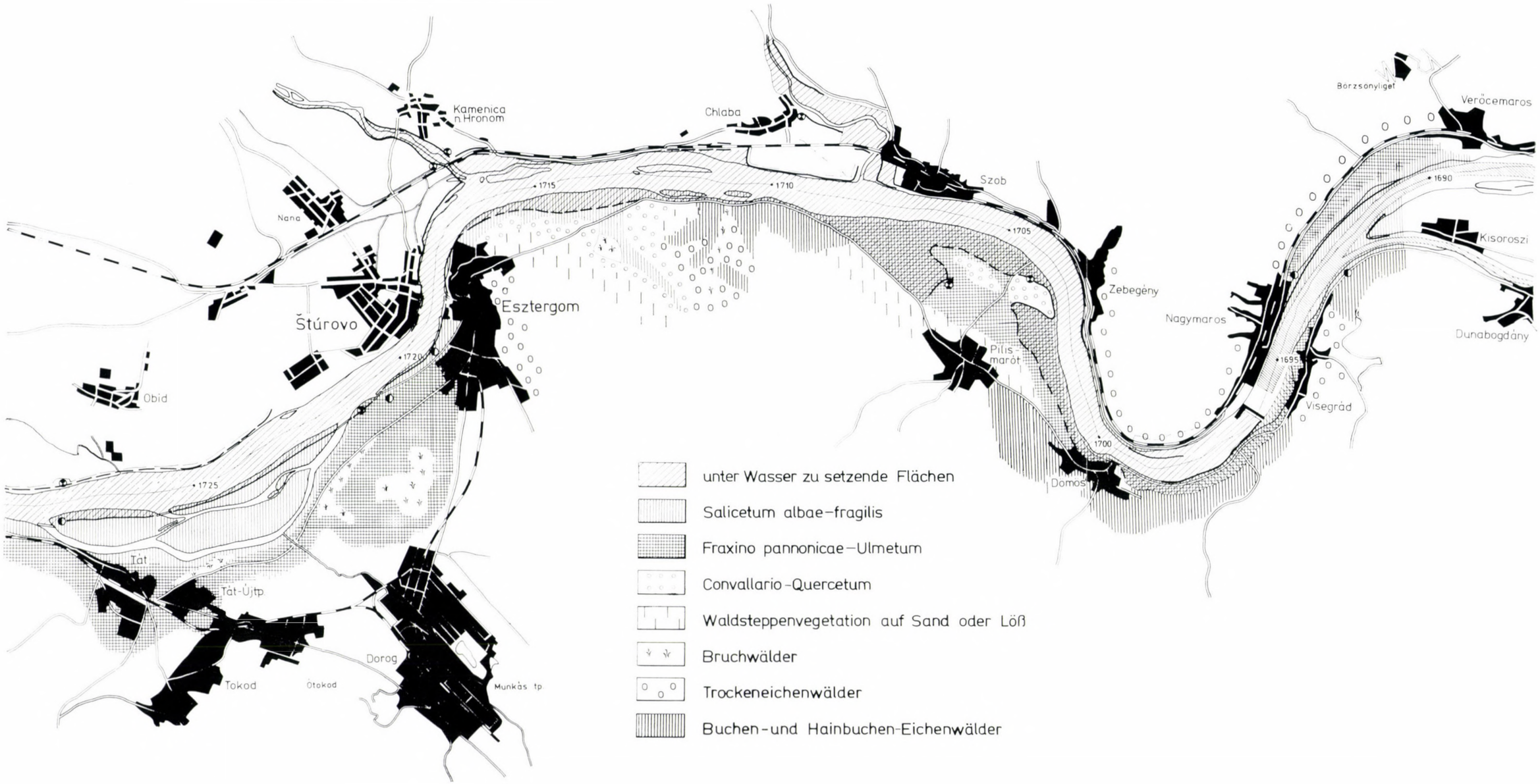

POTENTIALE VEGETATIONSKARTE DES DONAUTALES 3

Lehrstuhl für Pflanzensystematik und Oekologie der Loránd Eötvös Universität, 1978

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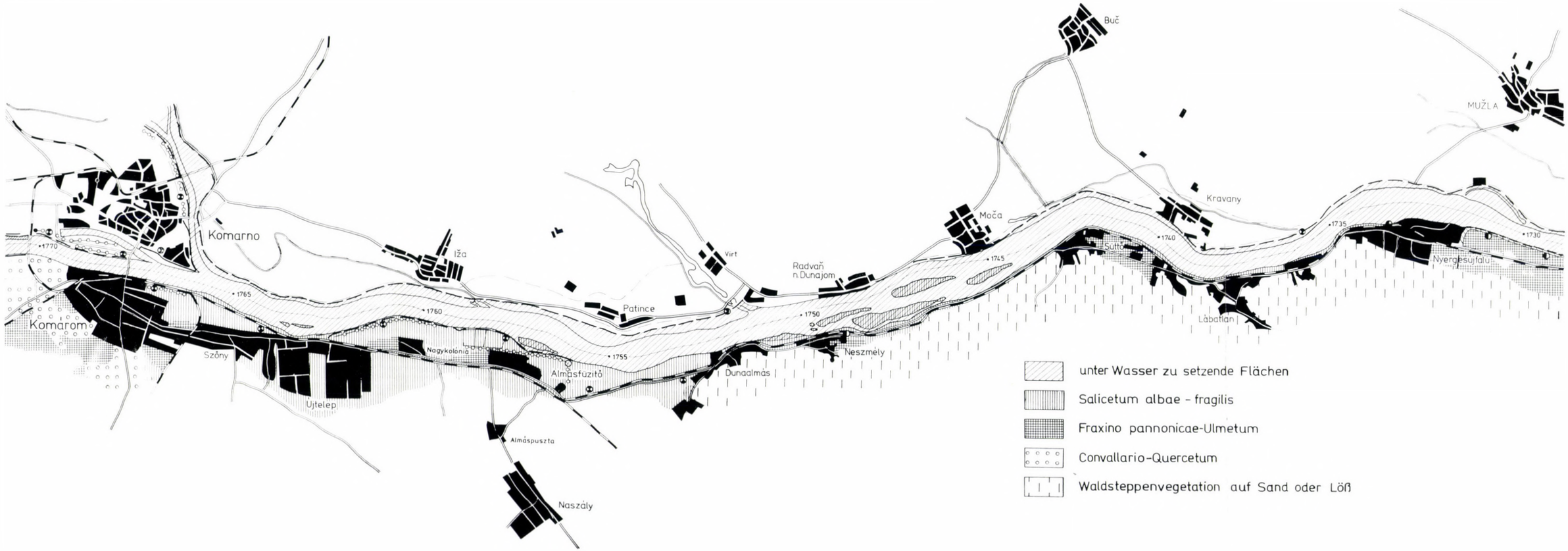

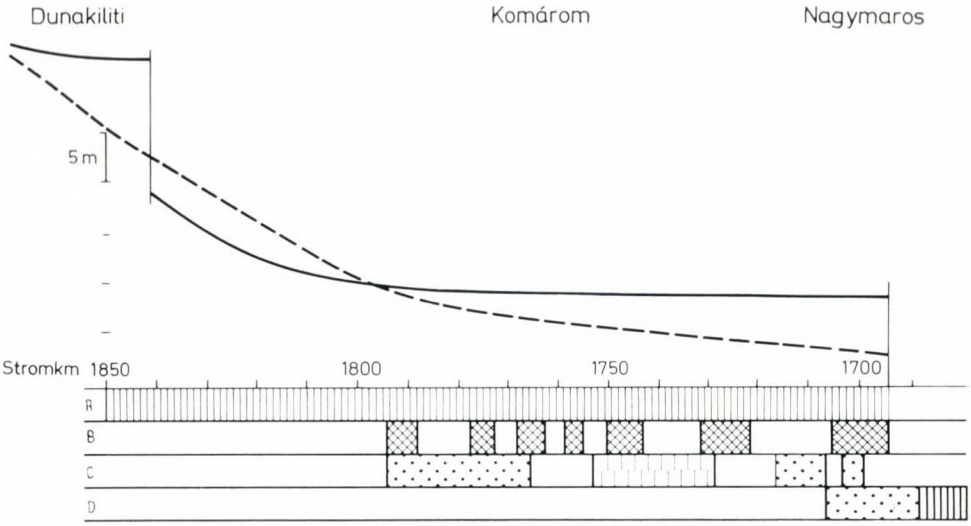

Abb. 1. Gegenwärtige und zu erwartende Höhe des durchschnittlichen Wasserstandes und das Vorkommen der auf der Vegetationskarte angegebenen Einheiten längs des Kraftstufensystems (Längenprofilentwurf). A. Unteres Inundationsgebiet B. Oberes Inundationsgebiet; C. Löß- und Sandrücken; D. Nord- und Südhänge

Abb. 2. Entwurf zur Schätzung der zu erwartenden Änderungen in der Vegetation. Im Falle der vertikalen Verschiebung der bei der Fügungslinie (.....) anpaßbaren Seite kann die Grundwasserhöhe, bzw. die infolge der Zunahme oder Abnahme der Inundation eingetretene Änderung in der Vegetation (natürliche, Halbkulturvegetation, Kulturvegetation) abgelesen werden

Gegenwärtige Vegetation				Veränderte Vegetation		
Potentielle	Halbkultur	Kultur	Meter	Potentielle	Halbkultur	Kultur
Convallario-Quercetum	Mähwiese, Weide	Acker	4	*Convallario-Quercetum*	Mähwiese, Weide	Acker
Fraxino pannonicae-Ulmetum	Wiesen u. Weiden im Inundationsgebiet	Acker im Inundationsgebiet	2	*Fraxino pannonicae-Ulmetum*	Mähwiesen im Inundationsgebiet	Acker im Inundationsgebiet
Salicetum albae-fragilis	feuchte Mähwiese o. Weide	vorübergehend feuchter Acker	0	*Salicetum albae-fragilis*	feuchte Mähwiese o. Weide	vorübergehend feuchter Acker
Salicetum triandrae	Sumpfwiese	—	2	*Salicetum triandrae*	Sumpfwiese	—
Flußbett-Unkrautvegetation	—	—	3	Flußbett-Unkrautvegetation	—	—
Schlammvegetation	—	—	4	Schlammvegetation	—	—
Laichkrautvegetation	—	(Fischteich)	6	Laichkrautvegetation	—	(Fischteich)

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FERTILIZATION OF FORESTS AND THE VEGETATION

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Author states that in the 6th year of forest fertilization, a harmful effect of the application of fertilizers, or signs indicating shift of harmful effects in the composition of the forest community at Őriszentpéter could not be observed. Therefore the question of the application of fertilizers is no cause for anxiety from the viewpoint of environmental pollution.

Introduction

All over the world there is a growing demand for wood, the raw material of forests. This has led to forest management experts to introduce various new means, among them the fertilization of forests, for increasing their wood production. In countries with a developed forest management large scale experiments on the fertilization of forests were launched or in some this is already an accepted feature of forest development (SZODFRIDT, 1973). Our country is not an exception either. About a decade ago methodological experiments in fertilization were initiated, first of all in the Euramerican poplar plantations, and in the pine plantations which had also been established artificially.

Fertilization, that is taking chemicals into forests, is not entirely without cause for anxiety, since forest ecosystems have so far been untouched by chemical agents. Therefore, the careful observation of environmental changes caused by fertilization is an indispensable task in forest development. A satisfactory indicator of changes can be the vegetation covering the soil, therefore, in areas of fertilization experiments, the examination of the soil cover vegetation is a concomitant to the evaluation of experimental results. In our study we wish to describe such an experimental series and present its results, as well as to draw conclusions whether a fertilization of given quality and quantity brings about changes in the conditions of the given habitat, and whether the trend of these changes is of a positive or a negative kind.

Experiments

The experimental area lies in the neighbourhood of Őriszentpéter, in the south-western part of Hungary, a few kms from the Hungarian—Yugoslavian border. The natural plant-cover of the area must have been hornbeam and oak grove, which after a later forest clearcut was planted with Scotch pine in 1954. At present, the crown-storey consists of a more-or-less closed pine forest. Its soil is a pseudogley-lessivated brown forest soil. Its climatic conditions are characterized by an annual precipitation of above 800 mm, and an average temperature of 9.8 °C. As the result of an Atlantic climatic effect, an early summer precipitation maximum can be observed, mostly in form of heavy rainshowers. Among the factors mentioned,

in a suitably edaphic environment pine forest can be regarded as indigenous, however, in our experimental area deciduous forests can be considered native. This is indicated by some plant species that have remained even after pine plantation, like *Fagus silvatica*, *Sanicula europaea*, *Viola silvestris*, etc. At the same time, frequent and characteristic species of the litter in Scotch pine forests, like *Pyrola*-types as well as the *Sieglingia decumbens*, also appear in the area.

The experiment was launched in 1972, by S. PROSZT—GYARMATI. Thus, the conditions described refer to the 6 years that have passed since the beginning of fertilization. The experiment contains four kinds of treatment and their fourfold repetition. An experimental plot is of an approximately 1000 m^2 range. The experimental variations are as follows: 1. Not treated, control; 2. 34 kg N + 80 kg P_2O_5, 3. 68 kg N + 120 kg P_2O_5 + 140 kg K_2O, 4. 136 kg N, + + 160 kg P_2O_5 + 240 kg K_2O. The data of the treatments dealt with refer to 1 hectare, the kg quantities represent pure effective agents. The quantity of fertilizer sprayed on the ground was hoed into the plots. The sampling of the vegetation was carried out with the usual sampling methods, by plots in June, 1978. The sampling data are presented in the table below. The plots of the individual treatments are discussed together; the usual K and A—D values were calculated, in the chart these are given instead of the individual plot sampling values. Since at the beginning of the fertilization experiment no vegetation survey could be taken, the evaluation can not be done but by making comparisons with the non-treated state. The data of the chart are placed in the order of ecogroups of forest plant species (CSAPODY, HORÁNSZKY, PÓCS, SIMON, SZODFRIDT and TALLÓS, 1963), and for the sake of simplicity we chose to put the data within them in alphabetical order.

Results

The following observations can be read from the table: the species of the *Bromus sterilis* group No. 11, and those of the similarly nitrophilous *Lamium maculatum* group No. 24, which contain species characteristic of fresh sites, did not appear in the vegetation even under the effect of the strong fertilization. Of the species of the *Urtica dioica* group No. 35 only the name-giving species of the group was present, and even that only sparsely in the control area, which thus indicates that the quantity of dose applied in the fertilization experiment did not pollute the environment till now. The species of the *Pyrola chlorantha* group No. 25 did not show changes following fertilization, thus in the species connected with Scotch pine forest there were no changes in the ratio of participation.

The members of the *Maianthemum bifolium* group No. 20 consisting of acidophil plants, the species living mainly in beeches and hornbeam and oak groves, but overlapping in pinewoods, occur largely in the same number after fertilization as well.

The species of the *Poa nemoralis* group No. 16, which are of wide ecological demand, and which draw into beeches rarely and into pine forests only quite exceptionally, increase in number after fertilization. Their appearance and their greater ratio in the fertilized plots are an indication that the conditions of litter decay have become more favourable and rather that favourable

Table 1

Ecol. group	Plant name	Experimental variations							
		1.		2.		3.		4.	
		A–D	K	A–D	K	A–D	K	A–D	K
5.	*Genista sagittalis*	—	—	—	—	+	II	—	—
1.	*Rumex acetosella*	+–1	IV	+–1	IV	+–2	IV	+–2	III
1.	*Peucedanum oreoselinum*	—	—	+	II	—	—	—	—
4.	*Euphorbia cyparissias*	+	II	+	II	—	—	+	IV
5.	*Carlina vulgaris*	—	—	—	—	+–	—	—	—
5.	*Festuca capillata*	—	—	—	—	+	II	—	—
5.	*Viscaria vulgaris*	+	II	—	—	—	—	—	—
9.	*Galium verum*	+	II	—	—	—	—	—	—
9.	*Hieracium bauhinii*	+	IV	+	III	+–1	II	+	II
9.	*Poa angustifolia*	+	II	—	—	—	—	—	—
10.	*Chrysanthemum corymbosum*	—	—	—	—	—	—	+	II
10.	*Quercus petraea*	+	II	—	—	+	II	+	II
10.	*Silene nutans*	—	—	—	—	—	—	+	II
10.	*Viola hirta*	+	II	—	—	—	—	—	—
12.	*Hypochoeris maculata*	+	I	—	—	—	—	—	—
16.	*Galium schultesii*	+	IV	—	—	+	II	—	—
16.	*Genista ovata* ssp. *nervata*	—	—	+	II	+	II	—	—
16.	*Pyrus pyraster*	+	II	+	I	—	—	+	I
16.	*Poa nemoralis*	+	III	1	II	+	IV	—	—
16.	*Satureja vulgaris*	—	—	+	II	+	II	+	II
16.	*Betonica officinalis*	+–1	III	—	—	+	II	+	III
16.	*Veronica chamaedrys*	+	IV	+–1	III	+	II	+–	III
17.	*Betula pendula*	+–1	IV	+–1	III	+	III	+	III
17.	*Hieracium sabaudum*	—	—	+	II	—	—	—	—
17.	*Sieglingia decumbens*	—	—	+	II	—	—	+	III
18.	*Carpinus betulus*	+–1	III	+–1	III	+	III	+–1	IV
18.	*Cerasus avium*	+	I	+	IV	+	III	+	IV
19.	*Myosotis silvatica*	+	II	—	—	—	—	—	—
20.	*Luzula pallescens*	+–1	II	+	I	+	I	+	II
20.	*Luzula pilosa*	1	II	+–1	III	—	—	+–1	III
20.	*Maianthemum bifolium*	+	II	—	—	+	II	—	—
20.	*Pyrola minor*	+–1	III	+–1	III	—	—	—	—
20.	*Ramischia secunda*	+	I	+	I	+	I	—	—
21.	*Viburnum opulus*	+	II	+	III	+	III	+	II
23.	*Carex silvatica*	—	—	—	—	+	II	—	—
23.	*Fagus silvatica*	+	II	—	—	—	—	+	II
23.	*Neottia nidus-avis*	—	—	+	II	—	—	—	—
23.	*Sanicula europaea*	+–1	III	+–1	III	+	IV	+–1	III
23.	*Viola silvestris*	+–1	IV	+–1	III	+–1	V	+–1	IV
23.	*Viola riviniana*	—	—	+	II	+	II	+	II
25.	*Moneses uniflora*	+–1	II	+–1	II	+	II	—	—
26.	*Hieracium sabaudum*	+	III	+	III	+	IV	—	—
26.	*Hieracium silvaticum*	+	III	+	II	+	I	+–2	II
26.	*Populus tremula*	+	I	+	I	+	I	—	—
26.	*Solidago virga-aurea*	—	—	—	—	+	II	—	—
26.	*Veronica officinalis*	+–2	IV	+–1	V	+–1	IV	+–1	IV
27.	*Athyrium filix-femina*	+	III	+	III	+	II	+	IV
27.	*Dryopteris spinulosa*	+	II	—	—	+–1	II	+	II
27.	*Oxalis acetosella*	—	—	1–2	III	—	—	2	II
28.	*Carex remota*	—	—	—	—	+	II	—	—
28.	*Deschampsia caespitosa*	+	IV	+	II	+	II	+	IV
28.	*Festuca gigantea*	—	—	+	II	—	—	+	II
28.	*Lysimachia nummularia*	—	—	—	—	+	III	—	—
28.	*Stachys silvatica*	—	—	1	II	—	—	+	II

Table 1 (continued)

Ecol. group	Plant name	Experimental variations							
		1.		2.		3.		4.	
		A–D	K	A–D	K	A–D	K	A–D	K
29.	*Holcus lanatus*	+	V	+	IV	+	II	+	III
29.	*Molinia coerulea*	+	II	+	II	—	—	+	II
29.	*Frangula alnus*	+	III	+	II	+	III	+	III
31.	*Epilobium montanum*	—	—	—	—	+	III	+	IV
31.	*Stellaria holostea*	—	—	+	II	—	—	—	—
31.	*Galium silvaticum*	+–1	V	—	—	—	—	—	—
33.	*Senecio fuchsii*	—	—	+	II	+	II	+	III
34.	*Ajuga reptans*	+–2	IV	+–1	IV	—	—	+	IV
34.	*Brachypodium silvaticum*	+–2	V	+–2	V	+–2	V	+–1	IV
34.	*Dryopteris filix-mas*	+–1	III	+	IV	+	VI	+–1	IV
34.	*Fragaria vesca*	+–2	IV	1	III	1–2	V	1–2	IV
34.	*Galium vernum*	—	—	—	—	—	—	+	II
34.	*Geranium robertianum*	—	—	—	—	—	—	+	II
34.	*Knautia drymeia*	1	II	+	II	—	—	—	—
34.	*Mycelis muralis*	+–1	III	+–1	IV	+–2	V	+–1	IV
34.	*Plantanthera bifolia*	+	IV	+	V	+	IV	+	IV
34.	*Quercus pedunculata*	+	II	+	III	+	III	+	II
35.	*Urtica dioica*	+	II	—	—	—	—	—	—
35.	*Circaea lutetiana*	—	—	—	—	+–1	II	—	—
38.	*Juncus effusus*	+–1	IV	+–1	V	+–1	IV	+–1	V
38.	*Solanum dulcamara*	—	—	—	—	+	II	+	II
39.	*Rubus caesius*	+–1	IV	+–1	V	1–2	IV	+–2	V
43.	*Lycopus europaeus*	+	II	—	—	—	—	—	—
44.	*Calamagrostis epigeios*	1	II	+	IV	+	III	—	—
46.	*Solidago serotina*	+–3	V	+–3	V	+–3	V	+–2	IV
47.	*Agrimonia eupatoria*	+	II	—	—	+	II	—	—
47.	*Crataegus monogyna*	—	—	—	II	—	—	+	III
47.	*Dactylis glomerata*	+	II	—	—	—	—	+	IV
47.	*Epipactis helleborine*	+	II	+	III	—	—	+	II
47.	*Euonymus europaeus*	—	—	—	—	—	—	+	II
47.	*Galeopsis pubescens*	+	II	—	—	+–2	II	1–2	II
47.	*Geum urbanum*	—	—	—	—	—	—	+	II
47.	*Hypericum perforatum*	+–1	V	+	V	+–1	V	+–1	V
	Lysimachia punctata	+	II	—	—	—	—	+	II
47.	*Prunella vulgaris*	+–1	II	—	—	+	II	+–1	II
47.	*Rumex sanguineus*	+	II	—	—	—	—	+	II
47.	*Stellaria media*	—	—	—	—	+	III	+	III
47.	*Veronica serpyllifolia*	—	—	+	II	+	III	—	—
—	*Achillea millefolium*	+	I	+	III	+	I	+	II
—	*Agrostis tenuis*	+–1	III	+–1	II	+–2	III	+	II
—	*Anthoxanthum odoratum*	+	I	+–2	II	+	I	+	II
—	*Berberis vulgaris*	+	I	—	—	—	—	—	—
—	*Campanula patula*	—	—	+	II	—	—	+	I
—	*Carex hirta*	+	II	+	II	+	I	+	I
—	*Carex leporina*	+–2	III	+–1	II	+–1	III	+–1	II
—	*Carex pilulifera*	1	III	+–1	IV	+–1	IV	+–1	III
—	*Dryopteris austriaca*	+	II	+–1	IV	+–1	III	+–1	II
—	*Leucanthemum vulgare*	+	IV	+	IV	+	II	+	II
—	*Galium mollugo*	+	I	+	I	—	—	—	I
—	*Galium rotundifolium*	+–2	IV	+–2	IV	+–1	III	1	IV
—	*Leontodon hispidus*	—	—	+	I	—	—	—	—
—	*Leontodon autumnalis*	+	I	+	I	+	I	+	II
—	*Lychnis flos-cuculi*	+–1	I	+	II	+	II	—	—
—	*Moehringia trinervia*	+	I	—	—	+	II	+	I
—	*Oxalis stricta*	+	II	+	II	+	III	+	III

Table 1 (continued)

Ecol. group	Plant name	Experimental variations							
		1.		2.		3.		4.	
		A–D	K	A–D	K	A–D	K	A–D	K
—	*Pimpinella saxifraga*	+	I	+	II	+	I	+	II
—	*Poa compressa*	+–1	I	1	I	—	—	—	—
—	*Poa pratensis*	—	—	—	—	+	I	—	—
—	*Potentilla argentea*	+	II	+	I	+	I	+	III
—	*Prunus spinosa*	—	—	+	I	—	—	—	—
—	*Ranunculus acer*	—	—	—	—	+	I	+	I
—	*Ranunculus repens*	+	I	—	—	+	II	+	II
—	*Rosa* sp.	+	II	—	—	+	I	+	II

changes ensued. The members of the *Antennaria dioica* group No. 5 consist of essentially acidophilous species, which are, however, characteristic of arid habitats following fertilization, they hardly changed in their ratio of participation.

The species of the *Melica uniflora* group No. 18 — which mostly play a significant part in hornbeam and oakwoods, but also in beeches and oak-forests — increased in number only to a small extent after fertilization. The number of plant species which have not been put into groups, and are not forest plant species, increased only to a very small extent; however, its connection with fertilization cannot be proved and it is rather the change in light conditions following the early thinning after the fertilization that can be the cause of that small numerical increase.

Summary

Summing up what have been said in the foregoing discussion we can state that in the 6th year following the fertilization, a harmful effect, of the application of fertilizers, or signs indicating a shift of harmful effect in the composition of the forest community could not be observed, therefore, the question of the application of fertilizers will have to be decided first of all by calculations with regard to the increase of timber production and the related questions of economy, while from the viewpoint of environmental pollution there is no cause for anxiety.

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STREUVORKOMMEN DER SCHWARZFÖHRE (*PINUS NIGRA* ARN.) AM ALPENOSTRAND

Von

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Author, based on ecological and phytocenological criteria, discusses the indigenous character of the northeastern isolated stands of the Illyrian black pine (*Pinus nigra* Arn.) occurring in the border of the Eastern Alps; defines the stands can be considered as indigenous ones and the other stands which proved to be product of reforestation. Expresses the opinion that localities of the black pine reported from Hungary and Czechoslovakia must be of anthropic origin.

Ausgehend von einer Untersuchung des disjunkten Teilareals der illyrischen Schwarzföhre an der Thermenlinie südlich von Wien (WDBG. 63a—c) konnte eine Reihe weiteren Einzelvorkommen der Schwarzföhre im weiteren Bereich des Alpenostrandes nachgewiesen werden (s. Tabelle 1).

Als Kriterien autochthonen Vorkommens der Schwarzföhre haben sich erwiesen:

Nach:

Relief, speziell:

1. Höhenlage: Vorkommen in der montanen Buchenstufe zwischen 300 und 700 m oder in der kollinen Eichen-Hainbuchen-Stufe zw. 260 und 500 m.

2. Exposition: Allgemein in Luv-Lagen mit deren Regen- und Wolkenstau — im Gebiet bevorzugt (aber keineswegs ausschließlich) Westlagen.

3. Hanglagen: Luftfeuchte und flachgründige Oberhanglagen.

Substrat, speziell:

4. Gestein: Dolomit, dolomitisierte Kalke; Serpentin (Bosnien).

5. Bodengründigkeit: Flachgründig-felsige Standorte.

Vergesellschaftung, speziell:

6. Unterwuchs: Straucharm bis nahezu strauchleer, nur wenige Individuen bestimmter Trockensträucher, wie *Amelanchier ovalis, Cotoneaster tomentosus, C. integerrimus, Berberis vulgaris, Sorbus aria, Rosa* sp., allenfalls auch *Viburnum lantana* und *Ligustrum vulgare*.

(Die Schwarzföhren-Aufforstungen auf den überaus kargen Standorten des Steinfeldes und Marchfeldes entbehren wohl gleichfalls des Strauchunter-

wuchses, doch fehlen in der Krautschicht nicht nur *Sesleria varia*, sondern alle anderen Zeigerarten autochthonen Vorkommens, an deren Stelle ausdruckslose *Festuca*-Rasen sekundären Charakters treten!)

7. Zeigerarten: Vor allem die Dominanz von *Sesleria varia*.

Die Zwergsträucher

Erica herbacea L.
Daphne cneorum L.
Polygala chamaebuxus L.

Im montanen *Euphorbio-Pinetum nigrae:*

Euphorbia saxatilis Jacq.
Thlaspi goesingense Hal.
Thlaspi montanum L.

Im kollinen *Seslerio-Pinetum nigrae:*

Thlaspi montanum L.
Galium austriacum Jacq.
Chrysanthemum lanceolatum (Pers.) E. Mayer

Ferner:

Rubus saxatilis L.
Phyteuma orbiculare L.

8. Artengarnitur:

Die Artenstruktur ebenso wie die standörtlichen Voraussetzungen (hinsichtlich der Höhenlage) läßt die Zugehörigkeit aller Vorkommen zum *Seslerio-Pinetum nigrae* erkennen.

Ein tabellarischer Vergleich der Artengarnituren der einzelnen Streuvorkommen zeigt einmal allgemein auftretende Elemente: Die obenerwähnten Trockensträucher sowie *Quercus petraea*, weiters allgemein verbreitete Trokkenrasenarten der Krautschicht, von denen bei der Beurteilung der Spontaneität des jeweiligen Bestandes abstrahiert werden muß:

Vincetoxicum hirundinaria	*Genista pilosa*
Anthericum ramosum	*Bupleurum falcatum*
Pimpinella saxifraga	*Teucrium chamaedrys*
Centaurea scabiosa	*Euphorbia cyparissias*

Eher in künstlich geforsteten Beständen findet sich *Pinus silvestris*, sowie in der Krautschicht *Asperula cynanchica* und *Silene vulgaris*. Dafür fehlen hier von den Trockensträuchern allgemein *Viburnum lantana* und *Rosa* sp., sowie in der Krautschicht *Campanula rotundifolia* und *Teucrium chamaedrys*.

Vitalität, speziell:

9. Wüchsigkeit der Schwarzföhre: Geringe Wüchsigkeit (jedoch bei geringer Schädlingsanfälligkeit, vgl. MALICKY 69. Vielfach Schirmkronenbildung.

Die Verjüngungsfreudigkeit allein ist noch kein Kriterium für Spontaneität!

Diese Kriterien treffen für die nachstehend aufgeführten Vorkommen in derart hinreichendem Ausmaß zu, daß an deren Spontaneität nicht gezweifelt werden kann.

So eindeutig nun aufgrund dieser Kriterien zwischen autochthonem und geforstetem Vorkommen unterschieden werden kann, so wenig läßt sich eine künstliche Einbringung von Schwarzföhren auf natürlichen Standorten nachweisen — was allerdings für die gegenständliche Fragestellung ohne Belang ist.

Die alpenfernen Randlagen dieser Streuvorkommen unterstreichen zum anderen das hohe Alter der Schwarzföhre, das auch aus diesem Grunde in das Tertiär verlegt werden kann. (WDBG. 63.)

Allgemeine Verbreitung

Die Schwarzföhren-Disjunktion an der Thermenlinie südlich von Wien erstreckt sich über ein ± geschlossenes Dreieck, dessen Hypotenuse an (westlich) der Thermenlinie zu liegen kommt und dessen Spitze westwärts bis an die Traisen reicht: »Somit verläuft die westliche Gränze des geschlossenen Schwarzföhrengebietes vom Höllenthale durch die Vois auf die Brunnthalerhöhe und weiter nordwestlich über Fahrabach, Kaumberg nach Alland und Kaltenleutgeben.« (BECK 1886: 337.)

Die westlichsten Grenzvorkommen liegen:

— »An den steilen, schwer zugänglichen, südlichen Abstürzen der Kandelhof-Mauer . . . mit 3.521' (1113 m) . . . zwischen Hohenberg und Lilienfeld im Gebiete des Traisenflusses.« (SECKENDORFF 1881: 28—29, auf KERNER zurückgehend), und zwar bei Innerfahrerfeld, n. von Furthof.

— Am Oberhang des Lorenzi-Pechkogels bei Eschenau a. d. Traisen, traisen-abwärts zwischen Lilienfeld und Wilhelmsburg gelegen und hier linksufrig des Flusses in 883 m (ZUKRIGL und KILIAN 66: 40).

Die Streuvorkommen

Das nördlichste authochthone Vorkommen der Schwarzföhre liegt unzweifelhaft am Wetterkreuz bei Hollenburg: »Auf Kalkkonglomerat zwischen Hollenburg an der Donau und Nußdorf an der Traisen (= ssö. von Hollenburg), der nördlichste Verbreitungspunkt.« (NEILREICH 1859: 229.)

Dieses Vorkommen wurde eingehend von ROSENKRANZ 24: 112—115 beschrieben, mit einem »Verbreitungsmaximum auf dem Spatzenberg und Schieferberg (richtig: Schiffberg) . . . wo sie ziemlich ausgedehnte Bestände, namentlich auf dem Rücken, bildet, die nur wenig von Rotföhre untermischt sind«. In diesem Gebiet wächst sie nicht nur in geschlossenen Beständen, sondern auch in kleinen Horsten oder auch nur einzeln, teilweise mit schöner Schirmkronenbildung und selbständiger Verjüngung.

Tabelle 1

Spontane Vorkommen		Kartenblatt der ÖK 1 : 50.000	Meereshöhe, m	Exposition	Gestein
Wetterkreuz bei Hollenburg, östlich der Kirche	Hollenburger Berge	38 Krems a. d. Donau	360		Hollenburger Kalkkonglomerat (Unter- und Mittel-Miozän)
Zeilerberg n. Winden	Leithagebirge	78 Rust	280	W	Kalk
Klausen bei Kalksburg	Kalk-Wienerwald	58 Baden	320—330	W (S/N) W	Hauptdolomit
Jesuitenkollegium Kalksburg	Kalk-Wienerwald	58 Baden	320	W-E verlaufende Gratlage	
Dunkelstein ö. Ternitz	Schwarztaal (südliches Steinfeld)	105 Neunkirchen	410	SW	Torton-Konglomerat
Oberster *Schergen-Seitengraben*, etwa wnw. des Krieriegels	Rosaliengebirge	106 Aspang/Markt	550	W	Dolomit (Obere Trias)
Steinkogel im Obersten Schergengraben, sö. Offenbach	Rosaliengebirge	106 Aspang/Markt	600—620	SW	Dolomit
Forchtenau, im Talschluß	Rosaliengebirge	106 Aspang/Markt	500	Kuppe	Dolomit
Pitten, Kirchen- und Schloßfels, oberhalb der Kirche	Bucklige Welt	106 Aspang/Markt	400—440	W	Kalk
Türkensturz bei Gleissenfeld	Bucklige Welt	106 Aspang/Markt	360—500	WNW	Dolomit (Obere Trias)
Unterkohlstätten: Steinwandriegel, sö. von Bernstein	Günser Gebirge	137 Oberwart	480(—500)	Kuppe (N)	Kalkschiefer
Dagegen haben sich einige Angaben als irrtümlich erwiesen — *Fehlanzeigen:*					
Gurhofgraben bei Aggsbach, S(W) Hang des Bärenköpfl	Dunkelsteinerwald	37 Mautern	380	S (W)	
Hirschberg im Traisental bei Meidling im Tale (südlich Krems)	Dunkelsteinerwald (Ost)	38 Krems/Donau	300—390	SE	

Schauerberg im Traisental, östlich Statzendorf	Unteres Traisental	38 Krems/Donau	380—390	W
Rotes Kreuz von Katzelsdorf	Fuß des Rosaliengebirges	76 Wiener Neustadt	(298)	
Kellerhaus bei Katzelsdorf	Fuß des Rosaliengebirges	76 Wiener Neustadt	300	W
Eichbüchl, Schloß	Fuß des Rosaliengebirges	76 Wiener Neustadt	380—400	SW
Kogel, westlich von Wiesen	Rosaliengebirge	106 Aspang/Markt	500—537	NW
Hohenstein, östlich von Stuben	Bernsteiner Gebirge	137 Oberwart	520—640	
Kienberg n. Bernstein	Bernsteiner Gebirge	137 Oberwart	790	
Táborhegy wnw. Kőszeg	Günser Gebirge	138 Rechnitz	646	
Péterics hegy sw. Velem	Günser Gebirge	138 Rechnitz	500—550	N
Plavecky Podhradie n. Rachsthurn	Kleine Karpaten			

Die Standorte dieses Vorkommens entsprechen durchaus anderweitig bekannten, spontanen Auftreten der Schwarzföhre: »Mit Vorliebe an nährstoffarmen, steinigen und schieferigen warmen Lehnen . . . besiedelt da namentlich die steileren und sterileren Hänge der Felsköpfe, . . . auf die sterilsten und ungünstigsten Stellen im Konglomerate beschränkt.«

Für ROSENKRANZ steht es außer Zweifel, »daß es sich um ein ursprüngliches . . . Vorkommen der Schwarzföhre handelt« — wobei ROSENKRANZ die künstlichen Aufforstungen im Gebiet eindeutig außer Acht läßt: »Daß also das Hollenburger Kalkkonglomerat den westlichsten und nördlichsten Ausläufer des natürlichen Verbreitungsgebietes der Schwarzföhre in Niederösterreich darstellt.«

Ähnlich bereits SECKENDORFF 1881: 28—29 (ebenfalls auf KERNER zurückgehend: »Als äußerste Vorposten urwüchsiger Schwarzföhre . . . in Niederösterreich: Die Mündung des Höllenthales, die Kandelhof-Mauer zwischen Hohenberg und Lilienfeld im Gebiete des Traisenflusses und die Höhen beim Wetterkreuze nächst Hollenburg.« Sowie BECK 1886: 337: »Die von

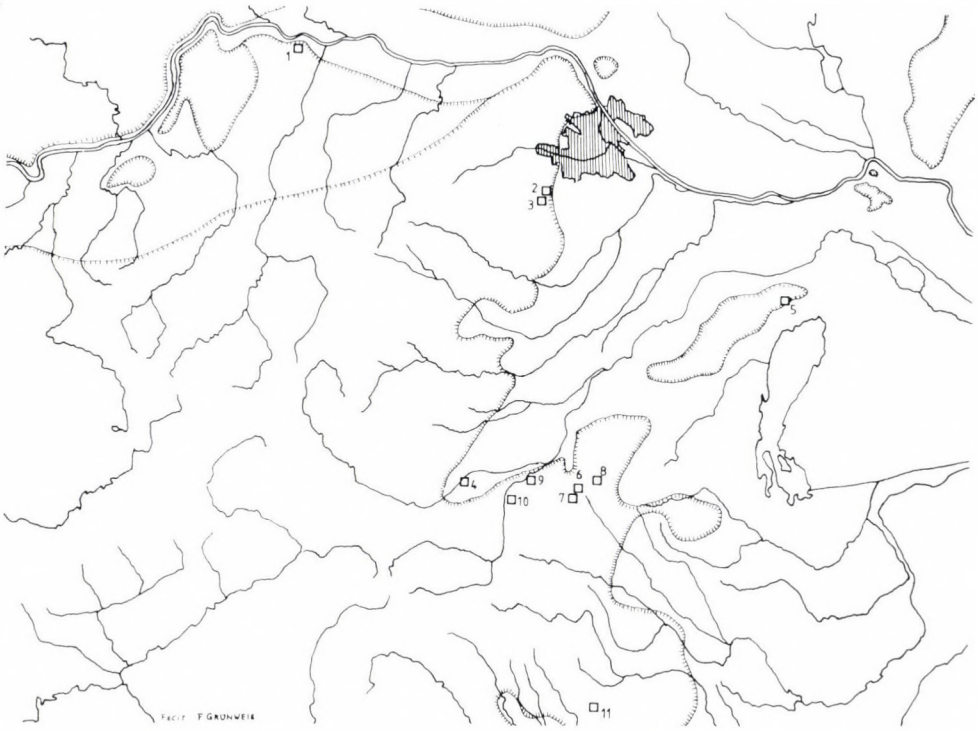

Fig. 1. Die Streuvorkommen der Schwarzföhre (*Pinus nigra* Arn.) am Alpenostrand. 1 Wetterkreuz bei Hollenburg; 2 Klausen bei Kalksburg; 3 Konvikt Kalksburg; 4 Dunkelstein bei Ternitz; 5 Zeilerberg; 6 Steinriegel im obersten Schergengraben; 7 Oberster Schergen-Seitengraben; 8 Talschluß von Forchtenau; 9 Kirche und Schloßfels von Pitten; 10 Türkensturz bei Gleißenfeld; 11 Steinwandriegel bei Unterkohlstätten

KERNER angegebenen westlichsten Standorte urwüchsiger Schwarzföhren: die Kandlhofmauer bei Hohenberg und die Höhen bei dem Wetterkreuze nächst Hollenburg, sind gleichsam als vorgeschobene, isolierte Posten derselben zu betrachten.«

Der spontane Charakter dieses Vorkommens bestätigt sich durch eine Aufnahme von dem Rücken unmittelbar westlich der Wetterkreuzkirche, westoffen durch den Einschnitt zwischen dem angrenzenden Schiffberg im N und dem Hollenburger Wald im S. Hier sind Kamm und SW-exponierter Oberhang dieses Rückens von unzweifelhaft spontanen Schwarzföhren, zusammen mit dominierendem Blaugras, bewachsen, während der Unterhang sowie der NE-Hang dicht von Laubhölzern bestanden sind. Überdies gibt ROSENKRANZ 24 aus dem Gebiete noch die charakteristischen Zwergsträucher *Erica herbacea*, *Polygala chamaebuxus* und *Daphne cneorum* an. Das Gestein ist in diesem Falle kein gewachsener Kalk oder Dolomit, sondern ein Kalk-Konglomerat.

Schwierig ist das isolierte Schwarzföhrenvorkommen auf dem Zeilerberg im nördlichen Leithagebirge zu deuten.

Hier wächst *Pinus nigra* in Oberhanglage auf Kalk, bei allgemeiner W-Exposition in 280 m, und zwar:

— Oberhalb eines *Corno-Quercetum*-Laubwaldes mit unzweifelhaft eingeforsteter Schwarzföhre.
— Umgeben von einer artenreichen *Carex humilis*-Rasensteppe unzweifelhaft primären Charakters, die nur auf der Hochfläche selbst durch Motorfahrzeuge rezent degradiert wurde.
— Diese Rasensteppe stellenweise durchsetzt von Trockengebüsch aus *Viburnum lantana*, *Prunus mahaleb*, *Berberis vulgaris*, *Juniperus communis*.
— An felsigen Stellen mit Elementen der Felssteppe, wie *Poa badensis*, *Teucrium montanum*, *Euphorbia seguierana*.

Für ein spontanes Auftreten sprechen:

— Westoffene Luvlage
— Beschränkung auf flachgründige Stellen zwischen Rasensteppe und Trockenwald am Oberhang
— Unregelmäßig-verstreutes Vorkommen der vereinzelten Bäume, was gegen eine künstliche Forstung spricht
— Vorkommen von *Sesleria varia* (wenn auch nur relativ spärlich) und *Daphne cneorum* (das allerdings auch im Rasen primär auftreten könnte?)

Gegen ein spontanes Vorkommen sprechen:

— Das Fehlen sonstiger, ausgesprochener Schwarzföhren-Zeigerarten
— Vielleicht auch der Nachwuchs von *Quercus pubescens* unterhalb von einzelnen Schwarzföhren, ohne Schwarzföhren-Jungwuchs selbst.

Trotz eines unzweifelhaft spontanen Eindruckes des Vorkommens muß die gültige Aussage über dieses Auftreten vorerst noch ausgesetzt bleiben.

Auf flachgründigen Oberhang-Westlagen in der Kalksburger »Klause« liegt das nördlichste authochthone Schwarzföhrenvorkommen der

subillyrischen Disjunktion an der Thermenlinie südlich von Wien: »Die Nordgrenze ihres geschlossenen Areals liegt bei der Kalksburger Klause südwestlich von Wien.« (ONNO 36: 116.)

Es handelt sich um ein relativ gehölzreiches Vorkommen auf flachgründigen Oberhanglagen, bzw. auf herablaufenden Felsrippen des Mittelhanges, speziell mit *Amelanchier ovalis* und bemerkenswert durch *Polygala chamaebuxus*, reich an *Sesleria varia* und an *Carex humilis*, mit etlichen thermophilen Elementen.

Überaus ähnlich zusammengesetzt ein kleineres Schwarzföhrenvorkommen unmittelbar sw. jenseits des Liesingbachtales, im Gelände des Jesuitenkollegiums Kalksburg, dessen Spontaneität bereits szt. von P. Dr. BRUNO TROLL-OBERGFELL angenommen wurde. Hier säumt die Schwarzföhre in einem schmalen Streifen den obersten, anstehend-felsigen Kamm beiderseits der Aussichtswarte (320 m) und von hier noch etwa 20 m nö. herabstreichend, von dominierender *Sesleria varia* begleitet, sowie mit *Polygala chamaebuxus* und *Thlaspi montanum*, jedoch gänzlich strauchleer. Die angrenzenden, tiefergründigen Hanglagen sind dagegen, dicht anschließend, von hochwüchsigem Laubwald bestockt.

Nahegelegen dem zusammenhängenden Schwarzföhrenareal (südlich) an der Thermenlinie liegt das Vorkommen auf dem Kirchfelsen von Dunkelstein östlich von Ternitz, hier auf abweichendem Substrat, nämlich tortonen Konglomeraten.

Dieses Vorkommen ist insofern etwas problematisch, als hier künstliche und natürliche Bestände einander durchdringen:

1. Dichtes Buschwerk des tiefgründigen SW-Hanges, von (geforsteten) Schwarzföhren überstanden.

2. Unterbrochen durch einzelne Gras- (*Sesleria*-) reiche »Glatzen« und zahlreiche Eschen-Schößlinge, jedoch ohne Schwarzföhre.

3. Die Kuppe mit anstehendem Fels und hier wohl autochthoner Schwarzföhre in unregelmäßigem Stand, auf kleineren Absätzen auch *Sesleria varia*, mit nur wenigen Trockensträuchern, wie *Berberis vulgaris*, *Viburnum lantana*, *Rhamnus saxatilis*.

Ein sehr schöner, großer, gut erhaltener Bestand zieht über beide Teilgipfel des Steinköpfl (Steinkogel) im obersten Schergengraben, Rosaliengebirge, hinweg, im Gipfelbereich mit anstehendem, größeren Dolomitfelsen und *Carex alba*-Fazies auf flachgründigen Oberhangstellen, vom Gipfel bei 620 m, sw. bis etwa 600 m herab und dann über einen dünnen Eichenschleier im Buchenwald übergehend.

Bemerkenswert ist das gemeinsame Auftreten etlicher Arten auf dem Steinköpfl, dem Kirchfelsen von Pitten und den Hängen des Türkensturzes

bei Gleißenfeld, nämlich: *Rosa* sp.; *Thalictrum minus, Campanula rotundifolia, Allium montanum.* Dafür fehlend: *Carex humilis, Melica nutans, Anthericum ramosum.*

Auf diese Lokalität und ein weiteres Vorkommen auf den Hahnenberg im obersten Schergen-Seitengraben (Forstabteilung 3b), gleichfalls im Rosaliengebirge, bezieht sich die szt. Angabe von NEUMAYER 30: 344 — »Rosaliengebirge: sicher wild im oberen Teile des Schergengrabens [!] bis zum Gipfel des Steinkogels (am Südhang dieses Berges hingegen nur aufgeforstet).«

Hier, gegenständlich, auf W-exponiertem Trias-Dolomit-Riegel ein Restbestand infolge einstigen Steinbruchabbaues hier. In floristischer Zusammensetzung von überraschender Ähnlichkeit mit dem Vorkommen auf dem Steinköpfl, vielleicht etwas weniger frisch, mit gleicherweisem Auftreten von *Phyteuma orbiculare* und einer *Carex alba*-Fazies auf flachgründigem Oberhang der Kuppenlagen.

Östlich anschließend am gleichen Hang ein *Seslerio-Fagetum*, übergehend in tiefergründigen Buchenwald.

Im Talschluß von Forchtenau ein von GUGLIA schon 1956 (n. p.) entdecktes, unzweifelhaft spontanes Vorkommen von mehr als 40 Bäumen, das auf die oberste, teilweise felsige Dolomitgruppe oberhalb der Steinbrüche im Talschluß von Forchtenau beschränkt ist (500 m). Der Bestand straucharm, mit dominierender *Sesleria* und verschiedenen Trockenheitszeigern, auf dem gegen NW abfallenden Riegel von der Rotföhre abgelöst, desgleichen auf dem ostexponierten Mittelhang seitlich des Steinbruches. Die tiefergründigen Hanglagen unterhalb sind von Buchenwäldern bestanden.

Auf dem Schloßberg oberhalb der Kirche von Pitten, auf von mächtigen Kalkfelsen durchsetztem, westexponierten Steilhang, bei mäßiger Wuchsleistung der Schwarzföhre, vor allem auf dem Felsen selbst, und hier mit Felsensteppen-Elementen, wie *Festuca pallens, Jovibarba hirta, Teucrium montanum, Sedum album;* ferner *Polygonatum odoratum* und *Potentilla arenaria.*

In mäßig gründigen Muldenlagen zwischen den Felstürmen, immer noch unter Schwarzföhre, artenreiche Trockenrasen.

Trotz des Hinweises von BECK 1890: 5 (»Wild von Kalksburg bis nach Seebenstein«) zumindest auf den Felsen südlich des Schlosses Seebenstein anscheinend überhaupt keine Schwarzföhren.

Unter dem Türkensturz bei Gleißenfeld mehrfach (und nicht wenig) auf anstehend felsigen bis flachgründigen Rippen des allgemein NW-exponierten Mittel- und Unterhanges von etwa 500 m bis an die Talsohle in 360 m herab, auf Trias-Dolomit. Die Aufnahme von einer WNW-verlaufenden Felsrippe läßt eine überraschende Ähnlichkeit mit den Beständen auf den Pittener Kirchfels erkennen, und zwar sowohl nach den beiderseitigen Felsrasen, wie den etwas gründigeren Trockenrasen.

Dagegen fehlt die Schwarzföhre sichtlich an den Kammlagen — vielleicht mit Ausnahme eines schmalen Streifens zwischen oberster Felskante und dahinter liegendem Laubwald (mit eingeforsteten Rotföhren).

Schon länger bekannt ist ein isoliertes Zwischenvorkommen bei Unterkohlstätten im Günser Gebirge — ein Brückenvorkommen zwischen dem Schwarzföhrenareal an der Thermenlinie südlich von Wien, mit den vorstehend besprochenen Streuvorkommen bis in die Bucklige Welt, und der Hauptverbreitung in Jugoslawien (mit Verbreitungsschwerpunkt in Bosnien und von hier aus ausstrahlend bis nach Südkärnten).

Es handelt sich um einen (ehemals) vielleicht 1000 m² großen Bestand gegenüber dem Steinwandriegel südlich von Unterkohlstätten, oberhalb des Steinbruches gelegen, durch den der Bestand heute fast schon vernichtet ist. (Ähnliches gilt durchaus für die Schwarzföhren-Streuvorkommen bei Forchtenau und im Oberen Schergen-Seitengraben !)

Hiezu GÁYER 29: 162, der sich seinerseits auf BORBÁS 1887 beruft: »Eine kritische Frage ist, ob auch *Pinus nigra* in unserem Gebiet heimisch ist. BORBÁS fand die Art auf Kalkschieferfelsen bei Oberkohlstätten (richtig: Unterkohlstätten). Das Vorkommen zeigt eine gewisse Analogie mit dem von ROSENKRANZ geschilderten isolierten Vorkommen der Schwarzföhre bei Hollenburg a. d. D. Auch *Sesleria varia*, die konstante Begleiterin der Schwarzföhre, kommt an dieser Stelle massenhaft und isoliert vor. Und da CLUSIUS gerade in dieser Gegend *Ruscus hypoglossum* fand, ist die Möglichkeit eines einstigen spontanen und isolierten Vorkommens der Schwarzföhre nicht von der Hand zu weisen«.

Ähnlich auch von NEUMAYER 30: 344 übernommen: »Auf Kalkschieferfelsen bei Oberkohlenstätten ebenfalls spontan (Bo, Gy).«

Bemerkenswert ist neben dem reichen Vorkommen des Blaugrases (*Sesleria varia*) das Auftreten von *Polygala chamaebuxus;* In der angrenzenden *Brachypodium pinnatum*-Fazies bereits einige Säurezeiger (*Genista tinctoria* und *Chamaespartium sagittale*, sowie etliche Laubwaldelemente, die nach dem benachbarten Buchenwald weisen.

Fehlanzeigen

Nicht bestätigt werden konnte ein spontanes Vorkommen für verschiedene Angaben aus dem Schrifttum:

Hirschberg bei Meidling im Tale, am östlichsten Dunkelsteinerwald: Ein Schwarzföhrenvorkommen auf steilem, flachgründigen SE-Hang, mit bemerkenswerten pannonischen Trockenrasen-Elementen (NIKLFELD, mdl.), jedoch kaum ursprünglich. Ähnlich auch ein von KRAPFENBAUER 67: 211 beschriebenes Vorkommen im:

Katzenmais, Hörfarthgraben zwischen Eichberg und Hirschberg, Revier ebenfalls Meidling im Tale, auf Serpentin, mit geringfügiger Beimengung der Schwarzföhre (mit

0,1) zur dominierenden Rotföhre (0,9), wohl mit *Polygala chamaebuxus*, aber gänzlich ohne *Sesleria varia*, reich an *Dorycnium germanicum*, mit einigen Säurezeigern (wie *Potentilla alba* und *Luzula luzuloides*), mit völlig abweichender Artengarnitur gegenüber den übrigen, verglichenen Schwarzföhrenvorkommen. Höchstwahrscheinlich also geforstet (und auch in einer etwa 20 Jahre alten Aufforstung gelegen).

Schauerberg östlich Statzendorf im untersten Traisental: Eindeutige Forstung mit einigermaßen dichtem Laubholzunterwuchs, ebenso wie am benachbarten Gerichtsberg.

Überaus bemerkenswert ist ein sporadisches Vorkommen der Schwarzföhre in Rotföhrenbeständen auf Serpentin im Gurhofgraben bei Aggsbach im (südwestlichen) Dunkelsteinerwald, am S (W)-Hang des Bärenköpfl im Oberen Mitterbachgraben gelegen. Über eine künstlich forstliche Einbringung der Schwarzföhre konnte hier nichts in Erfahrung gebracht werden. Auch schon bei KRETSCHMER 30: 174 und 194: »*Pinus nigra* (aufgeforstet)«.

Auch bei KNAPP 44 findet sich Schwarzföhre mit geringen Werten vertreten in Aufnahmen seines *Myosotidetum Gáyeri wachauense pinetosum* Var. v. *Dorycnium sericeum* = Kiefern-Serpentin-Vergißmeinnicht-Flur der Süd-Hänge.

Als Lokalität Aufnahme wird angegeben:

Aufn. 4: 550 m östlich der »Straßengabelung« in 360 m, SSE, 30°, *Pinus nigra* mit Deckung l

Aufn. 3: 700 m osö. der »Straßengabelung« in 390 m, SSW, 30°, *Pinus nigra* mit *Dekkung* r.

Hiebei kann es sich wohl nur um die »Straßengabelung« zwischen Aggsbach und Wolfsbachgraben handeln, und die beiden Aufnahmen nach Ortung auf der Karte von Oberhanglagen.

Allerdings liefert der tabellarische Vergleich dieser Aufnahmen mit den übrigen Streuvorkommen keinerlei Anhalte für ein spontanes Auftreten: Bei allgemein hoher Präsenz der Rotföhre (mit 4) fehlt *Sesleria varia*, bei abweichender Artengarnitur gegenüber den übrigen Vorkommen, vor allem mit Dominanz von *Festuca ovina* ssp. (mit 3) und dem Auftreten der Serpentinomorphosen *Myosotis sylvatica* subsp. *gáyeri* und *Dianthus carthusianorum* subsp. *capillifrons* (= *D. tenuifolius*).

Unzweifelhaft künstlich sind auch einige Vorkommen am NW-Fuß des Rosaliengebirges bei Katzelsdorf: »Am Steilrand des Gebirges östlich von Katzelsdorf (nördlich von Kellerhaus) vielleicht auch spontan (hingegen ist die Ursprünglichkeit des Standortes beim Roten Kreuz bei Katzelsdorf weniger sicher); möglicherweise wild auch auf den Felsen des Schlosses Eichbüchel; (JOHANNES GRASEL).« (NEUMAYER 30:344.)

Nördlich von Kellerhaus wohl in allgemeiner W-Lage an einem (niedrigen) Steilhang, jedoch auf Löß (!) und mit mächtigen Einzelbäumen bei dichtem Laubholzunterwuchs. Vergrasungen auf der Verebnung oberhalb des Steilrandes von nichtssagender, für Schwarzföhre untypischer Zusammensetzung aus allgemein verbreiteten Trockenrasenarten.

Ähnliches gilt wohl für die Angabe beim »Roten Kreuz« zwischen Eichbüchl und Frohsdorf, sowie für das — völlig laubwalddurchsetzte — Vorkommen auf dem Kleinen Riegel sö. des Schlosses Eichbüchl.

Ferner: »Wild vielleicht auch auf dem Gipfel des Kogls westlich von Wiesen (JOHANNES GRASL).« (NEUMAYER 30: 344.) Ein derartiges Vorkommen der Schwarzföhre überhaupt konnte am angegebenen Orte nicht bestätigt werden — weder für die anstehenden Felsen auf der Kuppe, oberhalb des Steinbruches, noch für den bodensauren Eichenwald des Westhanges (mit *Pinus sylvestris*, *Castanea sativa*, auch *Fagus sylvatica;* ferner *Quercus petraea* im Unterwuchs, *Vaccinium myrtillus*, *Avenella flexuosa*, *Genista tinctoria*, *Hieracium umbellatum;* an lichten Stellen *Calluna vulgaris*). Dessenungeachtet Kalkgestein! Allgemeine NW-Exposition.

Ein Hinweis bei TRAXLER 78 schien bemerkenswert: »Ein Vorkommen, das als ursprünglich angesehen werden könnte, entdeckte ich auf dem Hohenstein bei Stuben im Bernsteiner Gebirge auf Serpentin, 8563/4« und zwar auf einer Felsgruppe am SW-Hang des Hohenstein in etwa 620 m. Die Begleitflora hiezu wurde von TRAXLER nicht beachtet, jedenfalls *Sesleria varia* nicht wahrgenommen. (TRAXLER, briefl.)

Auch auf dem benachbarten Kienberg bei Bernstein einige Schwarzföhrenbäume auf dem Rücken inmitten schattiger Rotföhrenbestände (*Pino sylvestris-Festucetum ovinae* EGGLER 54) in SE-Exposition und hier unzweifelhaft in die Rotföhren eingeforstet.

Ein zweifellos interessantes, etwaiges Zwischenvorkommen auf dem Serpentin des Bernsteiner Gebirges zu den bosnischen Serpentinvorkommen ist jedenfalls nicht nachzuweisen!

Aus dem ungarischen Teil des Günser Gebirges liegen zwei Angaben vor:

Táborhegy (Burgberg) wnw. Kőszeg (Güns): »Kőszeg felett a Táborhegyen, Velem (?).« (Soó I: 559.) Hiezu konnten nähere Angaben nicht ausfindig gemacht werden.

Die von Soó mit Fragezeichen versehene, zweite Angabe von Velem (südlich von Güns gelegen) bezieht sich auf den Péterics hegy (Petritschberg) sw. von Velem (St. Veit). Über dieses Vorkommen gibt eine unveröffentlichte Studie von VIDA 56 (ungar.), das Ergebnis einer Studienkreisarbeit der Eötvös Loránd Universität in Budapest, nähere Auskunft, deren Vermittlung ich Herrn Dr. J. JEANPLONG, verdanke.

Die Analyse der einen Aufnahme (aus 500—450 m) von VIDA läßt die Spontaneität des dortigen Schwarzföhrenvorkommens überaus zweifelhaft erscheinen: Bei hoher Deckung von *Pinus sylvestris* (2.3) kommt *Pinus nigra* wohl in Spuren (mit +) vor, doch fehlt *Sesleria varia* völlig, ebenso wie alle kennzeichnenden Zeigerarten; statt dessen dominiert *Calamagrostis varia* (mit 5), begleitet von etlichen Säurezeigern, wie *Vaccinium myrtillus*, *Hieracium sylvaticum*, *Trifolium alpestre* und *Hierochloë australis*. Hiezu kommt noch die angegebene N-Exposition, wenngleich auf kalkhältigen Phylliten gelegen. Es dürfte sich hiebei um das *Calamagrosti variae-Pinetum sylvestris* Wdbg. 62 handeln — mit dominierender *Pinus sylvestris* und *Calamagrostis varia*, dem *Pinus nigra* normalerweise fehlt, das aber — jedenfalls für den Alpenostrand — erst für Höhen von 700 m aufwärts kennzeichnend ist. (Vgl. WDBG. 63b.)

Über ein Schwarzföhrenvorkommen in den Kleinen Karpaten (Plavecky Podhradie n. des Rachsthurn, nö. von Sološnica), untersucht von SČEJKA, Preßburg (Bratislava), konnte nichts Näheres in Erfahrung gebracht werden, ein authochthones Vorkommen scheint jedenfalls ebenso wenig wahrscheinlich.

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RECENSIONES

V. A. VACHRAMEJEV, I. A. DOBRUSCHKINA, S. V. MEYEN and E. D. ZAKLINSKHAIA: Paläozoische und mesozoische Floren Eurasiens und die Phytogeographie dieser Zeit. — Jena, VEB Gustav FISCHER Verlag 1978. 1—300. 30 figures, 2 tables

This book is a revised and abridged edition in German of the work published by 'Nauka' in Russian, Moscow 1970.

Following Professor R. DABER's Foreword and the authors' Preface, the work is divided into ten chapters, Chapters 1, 2 and 10 have been written by VACHRAMEJEV and MEYEN, Chapter 3, 4, and 5 on the Devonian, Carboniferous, and Permian floras by MEYEN. Chapter 6 by DOBRUSCHKINA on Triassic flora; Chapters 7 and 8 by VACHRAMEJEV on Jurassic and Cretaceous floras; and Chapter 9 by E. D. ZAKLINSKHAIA on the Lower Palaeogenic Palingenetic characterisation of the Upper Cretaceous system.

Chapter One, dealing with the methods in elaborating and evaluating the data, discusses the principles of palaeographic division based on palaeobotany, and the possibilities of palaeoclimatological reconstruction.

In Chapter Two, the history of the development of plantgeographical characteristics is presented the palaeozoic resp. mesozoic period, with respect to macrofloristical and palynological findings. The analysis of the plant coverage and its relation to lamellar-tectonical questions should be emphasized.

In Chapter Three, the Euro-Asian Devonian floras are described. In the Silurian, the terrestrial plants can not be completely proved. Very little data is available on the Devonian period, but macrofloristic findings and palingenetic data confirm that a great part of the deposits originates from aquatic plants.

Of particular interest to the fact that *Primofilices* and *Progymnospermae* deposits have been found from the Middle Devonian for the first time.

Beginning with the carboniferous period, numerous findings are available for research, and the material is discussed according to a uniform structure beginning with the Carboniferous flora. After a general description of the floras, the period is classified according to the evolution of the higher order plants. Then the plant geographical distribution of Euro-Asia is drawn up in terms of the individual units of the period: the stratigraphic boundaries of the main palaeoplant geographical units are set up by the authors. They characterise the floral domains and their floral areas by a stratigraphic order and present palaeofloristic maps of each period. The palaeofloristic and palaeoclimatologic characteristics of the period are also given.

Chapter 5 summarizes Permian floras, Chapter 6 Triassic floras, Chapter 7 Jurassic and Lower Cretaceous, Chapter 8 Upper Cretaceous floras, using the method described above (based on macro- and palinological data).

Chapter 9 summarises Upper Cretaceous and Lower Palaeogenic floras, on a palynological basis. The author emphasizes the differences in evaluating macrofloral findings and palinological data, and also that the latter fossils are more widespread. The changes in periods and the characteristics of the palynological floras of Euro-Asia are analysed; namely, the separation of the floras of *Normapolles* and *Aquillapollenites*, which is illustrated also on maps.

Chapter 10 summarizes the results the plant geographical zonal distribution and the evolution of the plant kingdom in the geological past.

The literature divided into two parts, palaeozoicum and mesozoicum consists of 38 pages in petit type setting. The work is completed with a name-index and an index of plant genera and species.

The enormous quantity of information has been compiled with great care and approached from a most modern outlook. The German edition makes this work available in another world language to non-Russian readers interested in this specialised literature.

L. NAGY (Mrs)

OLÁH, GY. M.—REISINGER, O.—KILBERTUS, G. (1978): Biodégradation et humification. Atlas ultrastructural. — Québec, Les Presses de l'Université Laval — Paris, Librairie Vuibert, 331 pp.

For progress nature needs the lasting co-operation of man. Unfortunately, it often happens that we forget to keep within bounds. Man has not always considered the consequences of certain cultivation methods and of intervention in the natural environment; which have led to the irreparable environmental damage. A large part of these miscalculations can be attributed to the inadequate knowledge of the biological properties of the soil.

Thanks to the techniques of ultramicroscopy, at present, we are already able to throw increasingly more light upon the multilevelled biodynamical processes, and at the same time upon their complexity, which make the removal of the organic matter possible.

Electronmicroscopic investigations of habitats recently, have revealed numerous proving the interaction among microorganisms, as well as their effect on natural products. The data obtained has been published elsewhere.

This work synthesizes the relevant researches and complements them with numerous new results.

The chapters of the book are as follows:

I — Schéma général de la biodégradation
- I — 1. Les producteurs

II — Principaux organismes intervenant dans le processus de biodégradation
- II — 1. Organismes non chlorophylliens
  - II — 1 — 1. Bactéries
  - II — 1 — 2. Champignons
- II — 2. Organismes photosynthétiques
  - II — 2 — 1. Bactéries
  - II — 2 — 2. Algues bleues
  - II — 2 — 3. Diatomées
- II — 3. Faune
  - II — 3 — 1. Organismes amiboides
  - II — 3 — 2. Nématodes
  - II — 3 — 3. Collemboles et Acarines

III — Chaîne trophique

IV — Décomposition des algues

V — Décomposition des champignons

VI — Décomposition des Bryophytes

VII — Décomposition des Phanérogames
- VII — 1. Décomposition de la litière
- VII — 2. Décomposition des racines

The structure of the book is excellent. The main chapters begin with a general discussion — illustrated in several places with schemes. Details are to be found on the right side with close on 200 mostly half-page or full-page illustrations the great majority of which are electronmicroscopic pictures; the left side contains the text to the illustrations, in French and in English. The work closes with an extensive literature of 20 pages, containing 369 references.

In studying this large format book with its outstanding fine layout, the reader cannot be amazed at the depths and fineness of the ultrastructure.

G. BOHUS

CULLEN, J.—DAVIS, P. H.: The identification of Flowering Plant Families. — 2nd ed., 1979. Cambridge Univ. Press.

This publication of small format is a rarity, and it makes up for a lack that had long existed in the literature on botanical subjects.

It was first of all specialists in the practice who were in need of such a concise and to the point practical taxonomic pocket-book, but garden-lovers, tourists and plant-lovers can

benefit from it. It was justified all the more so, since the enthusiastic work of plant collectors, and a more vigorous international tourism make it possible for us to become more familiar with the representatives of a number of plant families that were rare and inaccessible until recently. Although specialists have at their disposal detailed and thoroughly elaborated taxonomics and floral works, it is more expedient even for them in their everyday horticultural practice, especially for quick reference a pocket book like this.

With these ideas in mind, the first edition was published in 1965. It was sold out in a short time, and besides, in the light of new, first of all micromorphological and biochemical statements that accumulated during the past years it became outdated before long. The authors therefore, using the latest results, completely revised this 2nd edition published recently. The modern terminology, based on the construction of the flower, and Miss R. M. SMITH's unique illustrations are put together in a very clear compilation, with good practical sense, in the interest of developing a way of easy and quick identification.

A great merit of the authors is that they managed to publish a book comprising all the most frequently occurring families of the vegetable kingdom. For their taxonomy discusses, besides all the flowering plant families growing wild in the northern temperate zone, most of the plant groups that can be grown in culture, 272 in number. The boundary of their distribution zone can approximately be put at the 30° northern latitude, including Mexico, Florida, as well as the parts of India and China falling within this latitude. The authors based their work on the 1964 edition of ENGLER's Syllabus, which includes the whole vegetable kingdom in the most homogeneous way, and they built the results of the most modern taxonomists into that Syllabus. The phylogenetical system of the present book is based on the work of G. L. STEBBINS (Flowering Plants: Evolution above the Species Level; 1974), although — on the basis of the taxonomical results of other contemporaries — with slight modifications.

In the first, taxonomical part the most important botanical-technical terms, the ways of identifying the various families, and of using the taxonomical keys are described briefly. Then, the largest part deals with the system of taxonomical keys; this part is closed with short characterizations of the orders and families discussed. It is for the first time that we are given characterizations of important orders, even if only in one or two lines! At the end of the book, a list of references, a glossary and a family index give us a detailed identification of flowering plants.

When analysing technical terms, the authors do not strive to provide exact definitions, but to make them more understandable by means of clear and short descriptions and by explaining them in figures. An interesting aspect and modern characteristic of the taxonomic key system in this book is that it is based not primarily on the usual morphological characteristics and differences in life cycles, but, in accordance with the contemporary phylogenetical outlook, the greatest significance is attributed to the structure of the ovary, not only in the detailed parts, but already at the beginning of the main keys as well. In order to make an accurate differentiation in ovaries possible, in the definitions of upper-, mid-, or lower-situated ovaries the terms hypo-, epi-, and perigynous arrangement are used in a way that great emphasis is put on them. The authors' interpretation of the perigynous arrangement is entirely new, and this has a decisive influence here on the whole key system. As it is known, delimitating this term varies according to plant groups with different authors; it is not unambiguous and is sometimes rather problematic. The situation is made clearer by the attributes lower-, mid-, and upper-situated which refer to the relative arrangement of the ovary and the other floral parts as a whole, while the attributes hypo-, epi-, and perigynous are used for the internal arrangement of the flower, with respect to that between the ovary and the various floral parts taken in relation to one another, thus both the perigonium and the petal or the stamen can be of epi-, hypo-, or perigynous arrangement. Identification is very difficult first of all in the transitory states, mainly when the stamens spring from the upper part of the perigonium. Till now these arrangements of ovaries were described as partly of lower mode, partly of upper one. A solution is given here by clarifying the term perigynous arrangement in the above sense, that is, by relating it unambiguously to the mode of attachment of stamens and petals. The section in the petal leaf which extends from the petal base to the stamen's nodal point — in case the stamen springs from the petal, or at a certain phase the two have become attached — is called a perigynous zone in an upper-situated ovary, and an epigynous zone in a lower-situated one. Thus a new operation in identification is the observation of the mode of attachment, the nodes of the stamens, and the exploration of this new organ which has not been termed so far. The authors set 6 variations by means of the double notion system discussed; these variations, in addition to the 6 placentation basic forms already known, together with their several part types accessories provide a basis for differentiation.

Since the keys are built on the flower arrangement, this taxonomical system is not suitable for the identification of a plant group in its vegetative and native state either. Never-

theless, it is a great help for specialists and first of all for plant-loving non-professionals that the whole vegetable kingdom narrows down to 14 groups already at the head keys, then, by branching them off further, the user of the book can very quickly recognize the family. It is a great advantage also that with the help of the short characterizations of the families the possibility of 'reversed determination' also arises, when we can check whether the guessed characters of the family can indeed be found on the plant at issue. Naturally, the accuracy of our identification can also be tested in this way.

Last but not least, the extremely high didactical value of the book must be emphasized. By the frequent repetition of the short keys, which keep to the point, the most important characteristics of the orders and the families can possibly be learnt very easily, and while using the book our self-assurance in respect of identification will increase. — If this were its only feature, the book would already be an extremely good text-book for grammar school students but even more for university students.

Beyond the fact that it is an excellent and still simple manual for all plant-lovers possessing a medium level of plant culture, it can — by its advantages mentioned above — provide a great assistance also to specialists working in any of the fields of botany, first of all to those working in nurseries, botanical gardens or in the associated educational institutions.

Z. KERESZTY

ORLÓCI, L.: Multivariate analysis in vegetation research. 2nd edition. Dr. W. JUNK b.v. Publishers 1978. The Hague—Boston, 451 pp.

This second edition of the well-known handbook has been enlarged by about twofold. The author has retained the concept and the main structure of that of the first edition, but incorporated lots of papers, the results of recent years.

The mathematical approach is becoming indispensible in biological sciences in our days. This applies to vegetation ecology, too. Multivariate methods have found widespread application among research workers in many fields of biology. "This is not in the least surprising, considering that ecological data are normally multidimensional and that the analysis of such kind of data is most profitably accomplished via a multivariate method," — writes the author in his Preface. We must add that data not only in ecology but in many other fields of biology are multidimensional, therefore this statement of the author is true in those fields, too. Several biological sciences (ecology, taxonomy, agronomical research, anthropology, etc.) have been using the methods of the multivariate analysis for some years as part of routine-work and they should be used in many fields. This book was mainly intended for ecologists, but it would be of interest to anyone applying this type of mathematical analysis.

In this splendid handbook all the steps of research from data collection to the evaluation of the results are discussed in all thoroughness. The methods are collected and concisely described in a uniform style. Not only the uniform notation system, but the numerical examples worked out in detail make for easy comprehension. The application of multivariate analysis is inseparable from that of modern, high-speed computers. In the Appendix we can find computer programs of the most important algorithms written in the Basic language. They will help everybody intending to apply these methods but not being able to write programs. Among the 27 programs there are a number of new ones, compared with the first edition, and several programs of that edition have been revised and modified.

The book is supplied with a long list of references (26 pages), a concise glossary, an author- and a subject index.

The book — as the first edition — is divided into 6 chapters. Chapter 1 (Introduction) deals with the things to do before one starts an investigation. The first step is the correct formulation of the problem, which is essential for the success of the analysis. It is followed by the choice of the sample design, of the variables and of the mathematical model and method. The various methods of sampling and the problems (e.g. how to economize sampling, how to detect outliers, etc.) are discussed. In Chapter 2 (Resemblance functions) the indices are enumerated and discussed which characterize the similarity of square quadrats. Many metric and non metric functions are treated, the more frequently used ones (e.g. Euclidean distance, the coefficient of JACCARD, that of CZEKANOWSKI, or the RAJSKI's metric), and some neglected or new ones. It is a pity that the "shared species diversity" index of HUMMON (W. D. HUMMON, 1974, Oecologia, 17: 203—220), which has proved to be very efficient in some recent Hungarian papers, has been overlooked by the author.

The following 3 chapters treat two big families of the multivariate analysis, the ordination and the classification, and a close problem, identification. On account of the diversity of the methods only some of the most important methods treated will be listed; component and factor analysis; average linkage and sum of squares clustering; informational clustering; association analysis, etc.

Chapter 6 (Multivariate analysis — a discussion) one must consider the "directional light" of the book. After some general considerations of the methods treated it gives in clear tables a review of them. At the end of this chapter the author gives a "Prognosis", in which he discusses the present and the future of the multivariate, and in general, the mathematical methods in vegetation ecology and in biology. In any case at the end he cautions everybody not to overestimate ". . . the limits to which statistical and other mathematical methods can be put to useful service in plant ecology . . .".

This book is a splendid summary of certain types of multivariate analysis, which can be used in vegetation ecology and in other fields of biology. It will serve — like its first edition — as an up-to-date well-documented manual for the specialist and a clear text-book for the student.

M. RAJCZY

LIETH, H. and WHITTAKER, R. H. (eds.): Primary productivity of the biosphere. — Ecological studies 14. Springer, Heidelberg—Berlin—New York, 1975. 339 pp, 67 figs

The main objective of the International Biological Program was to make it possible for researchers to estimate the net primary productivity of the biosphere, that is the quantity of organic material annually produced in photosynthesizing plants and remaining in them after part of it has been used during their respiration. This net primary productivity in organic material is the basis of satisfying the material and energy needs in the whole biosphere of the organims beyond plants.

In addition to the editors, another 10 authors co-operated in the writing of the book — which is divided into 4 parts including 15 chapters altogether — in order to discuss the research results obtained on the primary productivity of the biosphere up to 1975.

In Part I—Introduction—the first chapter presents the sphere of topics and aim of its book (WHITTAKER—LIKENS and LIETH), while the second chapter provides a survey of the research history of primary productivity (LIETH). In this second chapter, conceptions and numerical data of the attempts to evaluate by quantitative approaches the organic material production of plants are flashed across the study, in a grouping—without a claim to completeness—beginning with ARISTOTLE to LIEBIG to the launching of the IBP, and finally dealing with IBP and its consequences.

In Part II, the methods of measuring the productivity are described. The material of Chapters 3—7 included in this part is as follows: Chapter 3 (HALL and MOLL), the methods of detecting primary productivity in waters; Chapter 4 (WHITTAKER and MARKS), the methods of detecting primary productivity in land; Chapter 5 (LIETH), measuring thermal values; Chapter 6 (SHARP—LIETH und WWIGHAM), detecting regional productivity by using the model of North-Carolina; Chapter 7 (SHARPE), methods of detecting the primary productivity of individual regions. In the methodological part, the authors use the results for making comparisons between the individual methods and give their critical remarks in order to eliminate the possibilities of making mistakes.

In Part III (Chapters 8—11), global productivity patterns are dealt with. First the primary productivity of the seas is discussed (Chapter 8, by BUNT); then the primary productivity of the water ecosystems of land (Chapter 9, by LIKENS); in Chapter 10 (by LIETH), the primary productivity of the largest biomes of the world, and finally, in Chapter 11 (by MURPHY), the net primary productivity of the tropical ecosystems of land are dealt with.

In the three domains, in land, in the oceans and in fresh waters, the net primary production is very varying, beginning from 2000 to 3000 g/m^2/year downwards to the point when in desert conditions it reaches the value nearing zero. In land, the great differences occurring in productivity are determined by the quantity of water utilizable; in fresh- and salt-waters, productivity is determined by the usable nutrient materials, while temperature has effect on productivity everywhere.

As a whole, plant associations on land are much more productive than those in the ocean, since land makes a large scale of association structures possible, keeping the nutrient materials and maintaining the leaf surfaces. The biomass of oceanic plankton associations, the chlorophyll and important nutrient material content there is much lower and so is productivity depending

on them. The effectiveness of light energy used for productivity purposes is in general linked with primary productivity, but the effectiveness of productivity by chlorophyll units is greater in the oceanic planktons than in the more productive forests. Depending on temperature and on biomass, the gross productivity part proportions turned into plant respiration vary from 75% measured in tropical rain forests to 20—30% measured in individual plankton associations. The energy content of the plant biomass of various associations on land varies by a definite system, from the low values of tropical rain forests to the high values of boreal forests.

Part IV deals with the utilization of research results related to primary productivity. In Chapter 12 (by LIETH), belonging here, modelling of world primary productivity is dealt with; in Chapter 13 (by BOX), the quantitative evaluation of primary productivity models brought about by means of computers; then in Chapter 14 (by LIETH), the viewpoints pointing beyond productivity measurements; and finally in Chapter 15 (by WHITTAKER and LIETH), the relationship between biosphere and man are dealt with by the authors. The earth's productivity maps, calculated and edited by various approaches are presented, moreover, by using the various measuring methods, the environmental factors and quantitative data related to the individual associations and to the biosphere as a whole, and on the basis of the relationship between primary productivity and the other characteristics of the biosphere as well as their consequences having relevance to man, the research results on the world primary net production are summarized. The total net primary production of the world is estimated at an annual quantity of 172×10^9 tons.

Since the time this book was published (1975) other numerical data based on newer measurements have come to existence on several points of the world. These partially modify the quantitative values given in the book, but they do not alter the validity of the statement which is summarized in the book as follows: "At the moment it seems that man will not be able to restrain the growth of his population and industry before serious damage is done to the biosphere. If he is to do so, he must set limits on himself and plan for wise long-term use and conservation of the biosphere, based on knowledge of its characteristics."

The book entitled 'Primary productivity of the biosphere', edited by LIETH and WHITTAKER, will for long be a handbook for those dealing with environmental protection and with the designing of future environmental plans, that is for ecology specialists, but those working in practice will also receive essential information and outlook from this book.

P. JAKUCS

* * *

Die Donau-Wasserkraftwerke und ihre Auswirkung auf die Forstwirtschaften

Das Ministerium für Forst- und Wasserwesen der Slowakei hat 1979 in Komarno im Themenkreis: »*Die Donau-Wasserkraftwerke und ihre Auswirkung auf die Forstwirtschaft*« eine Konferenz veranstaltet. Von den 12 Vortragenden haben sich 8 mit den Problemen der nach dem Aufbau des Stauwerksystems in der Forst- und Landwirtschaft zu erwartenden Schädigungen und ihrer Verringerung befaßt. Die Schädigungen ergeben sich aus der Abnahme der forst- und landwirtschaftlichen Flächen, jedoch vor allem aus den ungünstigen Änderungen der ökologischen Verhältnisse. Bei den Wäldern hat die größte Sorge der Ausfall der regelmäßigen Überschwemmungen (im Flutraum) und die Senkung der Grundwasserhöhe in das Kiesbett verursacht.

Das Wissenschaftliche Institut für Forstwesen Ungarns (ERTI) begann 1975 sich mit der auf die Wälder der Kleinen Schütt (Szigetköz) zu erwartenden Auswirkung des Stauwerksystems von Bős-Nagymaros zu befassen. Aus den mit Bäumen bedeckten 7,5 Tausend ha der Kleinen Schütt sind die Wälder im Flutraum die wertvollsten und am charakteristischsten, die ihr Gepräge auf die Landschaft aufdrücken. Der Standortsgegebenheit des Flutraumes der Kleinen Schütt ist zu verdanken, daß man hier im Landesmaßstab den größten Holzertrag erreichen kann. Auf den hervorragenden Standorten stehen an der Stelle der natürlichen Waldgesellschaften heute schon größtenteils Kulturpappelwälder mit hohem Massenertrag. Dies zeigt auch die prozentmäßige Verteilung der Baumarten dieses Gebietes an: Stieleiche 2,0; Robinie 5,8; Ahorn 0,5; Ulme 1,1; Esche 10,0; Edelpappel 47,7; einheimische Pappelarten 10,2; Weide 14,9; Erle 4,1; sonstige Laubhölzer 2,2; Rotkiefer 1,2; Schwarzkiefer 0,3. Die Edelpappelwälder sind nicht nur von großem Holzertrag, sondern fügen sich durch die eigenartige Forstwirtschaft gut in das natürliche Bild der Landschaft ein.

Das »Armsystem von Ásványráró« ist ein typisches Modellgebiet in der Gemarkung der Ortschaft Lipót, es beträgt insgesamt 306 ha. Im Jahre 1975, sodann 1977 haben wir im ganzen genannten Gebiet Standorts- und Bestandsuntersuchungen durchgeführt. Die gegenwärtigen natürlichen Gegebenheiten wurden mit den zu erwartenden Änderungen verglichen. Die Kleine

Schütt zeigt mit ihrem trockenen, warm-heißen Sommer und mäßigwarmen, milden Winter ein Makroklima mit Übergangscharakter, jedoch besitzt der Flutenraum ein eigenartiges Mikroklima. Die zahlreichen Donauarme, toten Arme, abflußlosen, tief gelegenen Sumpf- und Schilfgebiete, die häufigen Überschwemmungen schaffen im Vergleich zum Makroklima eine wesentlich größere Dunstigkeit. Dies beweist das Erscheinen der Hainbuche und von zahlreichen Krautpflanzen.

Im Flutraum der Kleinen Schütt, jedoch auch an den betreffenden, sämtlichen Donauinseln bildet die Überschwemmung und der damit einhergehende Grundwassertidenhub in entscheidender Weise die Produktivität, d. h. die Baumartenzusammensetzung der Waldgesellschaften und das Wachstum der Baumbestände. Die zur Zeit außerordentlich günstige hydrologische Gegebenheit ergibt sich aus der Überschwemmung der Oberfläche durch die regelmäßigen Flutwellen und durch den auf die Wirkung dieser auftretenden Grundwassertidenhub gemeinsam. Diese Gesamtwirkung wird von der aufgrund der Humusschicht in verschiedenen Tiefen befindlichen Terrassenkiesschicht gefördert. Das Wasser der Überschwemmungen, selbst im Falle der kleineren Flutwellen — wenn es auch nicht zur Überschwemmung der Oberfläche kommt — begießt von unten das Gebiet, d. h. das in die Kiesschicht rasch eindringende Wasser füllt kapillar die darüber gelegene Bodenschicht bis zur Wasserkapazität auf, ja selbst die Wurzeln der Bäume erhalten frei aufnehmbares Wasser. Diese auffüllende Wirkung wird auch von der sandigen Bodenstruktur gefördert.

Die Humusschicht der Böden der berührten Gebiete hat sich aus holozänen Aufschüttungen ausgebildet. Auf den im Flutraum vorhandenen Inseln ändern sich mosaikartig die rohen Aufschüttungen mit den humösen. Für die Böden der Kleinen Schütt ist die in verschiedenen Tiefen vorfindbare Kies- oder grobe sandige Kiesschicht charakteristisch. Insofern die Kiesschicht durch die Führung der Gewässer der Flutwellen optimale hydrologische Verhältnisse bedeutet, ebenso nachteilig ist es, wenn die Flutwellen ausbleiben.

Das Ergebnis der gegenwärtigen günstigen Gesamtwirkung des Standortes ist, daß das Durchschnittswachstum der Edelpappel- und der Weißweidenbestände 24—30 m^3, während das der Weiden-Pappel-(»Weichholz«)-Auwälder (gemischte Weißpappelwälder) nur 15,5 m^3 beträgt. Die von B. Zólyomi beschriebenen (1937) Waldgesellschaften der Kleinen Schütt sind nur mehr in Fragmenten anzutreffen, jedoch haben die Kulturwälder mit hohem Ertrag die Landschaft nicht verändert. Es liegt außer Zweifel, daß heutzutage die natürliche Sukzession überhaupt nicht, oder nur in verschwindend geringem Maße zur Geltung kommt, jedoch die rationelle Forstwirtschaft keine Degradation der natürlichen Gegebenheiten verursacht.

Durch das sich im Bau befindende Kraftstufensystem von Bős-Nagymaros wird die Überschwemmung des Flutenraumes und der Grundwasserspiegel grundlegend verändert. Die regelmäßigen Flutwellen bleiben aus, zeitweise überschwemmt jedoch je eine größere Wassermenge das Gebiet. Das Grundwasser versinkt in die Kiesschicht und so hört der Wassernachschub der Oberfläche auf, die Absaugwirkung der Kiesschicht wird sogar die Trockenheit der Humusschicht steigern. Die Austrocknung des Standortes zieht die Änderung der Landschaft mit sich, es tritt nicht die Sukzession der Wälder, sondern ihre Degradation ein. Die ökologischen Verhältnisse wirken sich nicht nur für die Land- und Forstwirtschaft ungünstig aus, sondern ändern sich auch vom Gesichtspunkt der Fischerei, der Mehrzweckbenutzung der der Wälder, wie auch des Umweltschutzes in ungünstiger Weise. Diese ungünstige Auswirkung zeigt bei Bratislava der Waldblock von Dunapüspöki. Die Wasserversorgung des Gebietes war durch den toten Arm der Donau gesichert, jedoch wurde diese wegen der Industrieförderung gesperrt. Die Überschwemmung hat aufgehört, selbst am Grund des Bettes des toten Armes ist kaum etwas Wasser zurückgeblieben, das Grundwasserniveau hat sich um 2 m in die Kiesschicht versunken. Infolge der Austrocknung ist der Weidenbestand völlig, ferner 50% des Edelpappelbestandes und 25—30% des Weißpappelbestandes heute bereits zugrunde gegangen. Das Bild verschlechtert sich von Jahr zu Jahr. Das Beispiel von Dunapüspöki zeigt die zu erwartende Degradation, die in den Ökosystemen der Wälder eintretenden wirtschaftlichen und ökologischen Schädigungen, aber noch mehr die Änderung des Charakters der Landschaft der Kleinen Schütt. Zur Abwehr der Änderung gibt es heute noch keine angenommene Lösung, jedoch im Interesse der Verringerung der Schäden müssen wir alle zusammenhalten und alles in Gang setzen. Hierzu fordert mit ihrer Empfehlung die Konferenz von Komarno auf:

»*Es soll untersucht werden, inwiefern man nach dem Bau des Stauwerksystems mit dem in den toten Armen der Donau auszubildenden einheitlichen Wasserwirtschaftsystem durch die mit Schleusen kombinierten Abschlußdämme die infolge der Senkung des Grundwasserspiegels eintretenden Sorgen des Umweltschutzes und unter ihnen die Probleme der Forstwirtschaft verringern könnte.*«

Z. Járó

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ЗАМЕЧАНИЯ О КУБИНСКОЙ *BIGNONIACEAE*, I. НОВЫЕ ВИДЫ РОДА *TABEBUIA* НА КУБЕ

А. БОРХИДИ

Автор описывает 7 новых таксонов, 5 новых видов, один гибрид и одну разновидность из рода Tabebuia на Кубе. Все эти таксоны кубинские эндемизмы и новые для науки. Они следующие: ***Tabebuia perelegans*** **sp. n.**, ***T. zolyomiana*** **sp. n.**, ***T. triorbicularis*** **sp. n.**, ***T. triorbicularis*** **Borhidi var.** ***obovata*** **var. n.**, ***T. capotei*** **sp. n.**, ***T. del-riscoi*** **sp. n.**, ***T×rosariensis*** **hybr. n.**

КАРТА ПОТЕНЦИАЛЬНОЙ ВЕГЕТАТЦИИ КУБЫ

А. БОРХИДИ, О. МУНИЗ

Авторы изготовили карту осадков и биоклиматологии Кубы. Они определили, что в Кубе можно найти 5 больших климатических типов, и их 12 разновидностей: полупустынный климат (1 разновидность), зимой сухой тропический климат с 1 сухим перйодом (3 разновидности), с 2 сухими периодами (4 разновидности), весь год тропический климат (2 разновидности) и целый год влажный субтропический горный климат (2 разновидности). Эти климатические условия дают возможность образованию 9 климатических растительных зон: 1. зона полупустынных кустарников, 2. зона наполовину листопадных и вернозеленых кустарников, 3. зона летом зеленых тропических лесов, 4. зона наполовину вечнозеленых тропических лесов, 5. зона сезональных вечнозеленых тропических лесов, 6. зона субмонтанных тропических дожде вых лесов, 7. зона монтанных тропических дождевых лесов, 8. зона мховых или туманных лесов, 9. зона высокогористыхвечно зеленых кустарниковых лесов. Разновидность почв и основных пород кондиционируют повышенную изменчивость растительного покрова внутри зон. Карта вегетации вместе с незональной растительностью морского побережья указывает на распространение 10 больших вегетационных типов и внутри них 34 вегетационных единиц. Авторы далее занимаются экологическим влиянием серпентина на образование тропической флоры и вегетацию. Авторы обсуждают проблему происхождения кубинских саванн, и на отдельной карте обозначают оригинальные места саван, а также местность, которая превращается в саванны, и во вторичные антропогенные саванны. Анализируя происхождение кубинской флоры определяют большую роль эндемических родов и видов (более, чем 50%). Они предполагают, что в развитии-истории кубинской флоры было 3 периода

а) период самостоятельных Антил-пластин, от которых остались древние реликты (*Mycrocycas*, *Cneorum*, *Dracaena*).

б) период континентальных мостов, когда неотрофическая флора переселилась на Антиллы

с) период изоляции, когда острова отделились от континента и друг от друга и началась специализация флоры и эволюция эндемических таксонов.

ПАЛИНОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ ЧЕТВЕРТИЧНОЙ ЭРЫ В ЗАПАДНОМ БЕРЛИНЕ

А. БРАНДЕ

Автор показывает настоящее положение палинологических исследований четвертичной эры в Западном Берлине, и отдельное внимание обращает на плейстоценные доказательства тех богатых елью лесов сукцессионного холоценного типа, которые образовались под влиянием последнего глациального периода на субконтинентальных ландшафтах на песках.

СРАВНИТЕЛЬНЫЕ МОРФОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ ПОПУЛЯЦИЙ ПЕСЧАНОЙ ОВСЯННИЦЫ (*FESTUCA VAGINATA* W. et K.) I.

(Tece studies 'No. 15)

А. ХОРАНСКИ, Г. ФЕКЕТЕ, И. ПРЕЧЕНЬИ, ДЬ. ТЁЛЬДЬЕШИ

Особи из популяции Festuca vaginata, происходящие из трех различных мест были реципрокно пересажены с целью проследить различные морфологические изменения соцветия у этих особей. В 1978 году авторы исследовали вариабильность морфологических признаков в популяции у исходных образцов и пересаженных образцов (длина метелки, колоса, междоузлий, длина больших и маленьких чешуй). В 1977—78 годах они исследовали две вацратотских популяций различный по цвету колоса. Популяции, растущие на исходном участке показали видовую принадлежность по признакам длины метелки, междоузлий и чешуй. А в трех популяциях наблюдалось внутривидовое различие по длине метелки, по длине чешуи и по образованию отростка чешуи. Особи популяций, пересаженных в Фюлёпхаза и в Вацратот можно было сравнить с местными популяциями в 1978 году. На основе исследований длина метелки, по которой различались популяции, можно рассматривать только как пластический экоморфизм.

РЕКОНСТРУКЦИЯ ЗАПАСОВ ПОТЕНЦИАЛЬНЫХ ПЕРВИЧНЫХ ОРГАНИЧЕСКИХ ВЕЩЕСТВ И ИХ РЕПРОДУКЦИИ В ВЕНГРИИ

П. ЯКУЧ

В статье содержатся данные по количеству бывшей продукции или по количеству бывших первичных органических веществ, высчитанных на территорию Венгрии, вернее на территорию отдельных небольших ландшафтов. Реконструкция произошла при помощи использования потенциальных карт вегетации, а также при расчете данных о биологической продукции главнейших величин вегетации. Для расчета биологической продукции различных величин вегетации авторы использовали измерения в лесу, а также самые новые венгерские и международные данные по фитомассе и продукции.

В Венгрии до влияния человека на площади 93 км² насчитывалось $494{,}7 \times 10^7$ тонны органического материала (рассчитано на абсолютный сухой вес). Среднее количество фитомассы в стране приходилось 531,77 т/га. Главные причины отклонения количества органического материала по ландшафтам страны заключались в потенциальных окружающих условиях, а также в различии удельного веса различных древесных видов. Выше указанные потенциальные запасы органических веществ, производимые страной за год равнялись $17{,}8 \times 10^7$ тонным (сухой материал). А среднее количество продукции на гектар равнялось 19,19 тонн за год. Запасы органических веществ, накапливаюшихся в теперешнее время в Венгрии составляет всего 4% органического вещества, накапливающегося в прежнее время.

АККУМУЛЯЦИЯ ПИТАТЕЛЬНЫХ ВЕЩЕСТВ В ВОДНЫХ МАКРОФИТАХ

КАРПАТИ, И.—КАРПАТИ, В.—ПОМОДИ, П.

Авторами было изучено действие изменений концентрации биоэлементов места обитаний (вода) на накапленные в различных органах Nuphar lutea питательные вещества. Были проведены корреляционные рассчёты по отношению места обитания и растения. Существующие между аккумулированными в отдельных органах биоэлементами положительные, или отрицательные взаимодействия выражались путём анализа линейной регрессии.

ИЗУЧЕНИЕ ТРАНСПОРТА ПИТАТЕЛЬНЫХ ВЕЩЕСТВ В ПОЧВЕ ДУБОВОГО ЛЕСА

М. КОВАЧ

Автор в результате исследования круговорота биоэлементов в экосистеме дубового леса определил количество элементов попадающих в почву и уходящих из нее при размытии. В химическом составе раствора, так называемого подстилки-лизиметра есть сезональ-

древенистыми подземными стержневыми образованиями и маложивущими, почти безстебельными надземными побегами и огнестойкими плодами. Они способны пережить и повторяющиеся пожары, и через три недели после пожара проростают и приносят цветы. Возможно, что главную роль в эволюции геоксильных полукустарников, живущих в африканских саваннах, играли пожары.

ХИМИЧЕСКОЕ СОСТОЯНИЕ АТМОСФЕРЫ ПРОМЫШЛЕННЫХ РАЙОНОВ И ПРИРОДНАЯ РАСТИТЕЛЬНОСТЬ

Р. НЕУХАУЗЛ

Промышленная деятельность человека настолько изменяет в наши дни отмосферные отношения, что становится несущественным потенциальное естественное картирование. Загрязнение воздуха в промышленных районах достигает таких размеров, что это препятствует не только процессу природной сукцессии, но и сохранению естественного растительного покрова. Поэтому автов предлагает внести термин гипотетической вегетации, который обозначает климакс растительности в измененных условиях, возникший в результате деятельности человека.

БИОМАССА ЭПИФИТА И ЕЕ ВЛИЯНИЕ НА ВОДНОЕ ХОЗЯЙСТВО ДВУХ ДОЖДЕВЫХ ЛЕСОВ В ГОРАХ УЛУГУРУ (ВОСТОЧНАЯ АФРИКА, ТАНЗАНИЯ)

Т. ПОЧ

Автор определил в субмонтанном дождевом лесу количество биомассы эпифита-2130 кг/га и её интенсивную продуктивность-15 000 л/гектар. Также биомасса на высоте 2120 м в мховом карликовом лесу равнялась 14 000 кг вернее 50 000 л/гектар. Количество надземного гумуса, образованного эпифитами было гораздо больше в мховом карликовом лесу (4700 кг/га), чем в субмонтанном дождевом лесу (375 кг/га). Автор нашел корреляцию между уже не влияющим на макровегетацию общим количеством дождевых годовых осадков и количеством эпифитной биомассы в условиях дождевого леса.

КЛАССИФИКАЦИЯ ЭКОЛОГИЧЕСКИХ ТИПОВ ЛАНДЩАФТОВ В ЦЕНТРАЛЬНОЙ ЕВРОПЕ

Г. И. РАДКЕ

Автор описывает роль экологической концепции в оценке и классификации географических районов. Автор дает объяснение термину ландшафт-экология и подчеркивает важность концепции этого термина в защите природы и в планировании и использовании местности. Автор считает, что растительные сообщества являются самыми подходящими природными организмами для характеризования типов местности и их классификации. Автор также показывает экологическую классификацию подготовленную с центрально-европейских типов ландшафта, в которой каждому типу соответствует более высокая фитоценологическая систематическая единица.

СРАВНИТЕЛЬНЫЕ ИЗУЧЕНИЯ ПЛЕЙСТОЦЕНОВЫХ БУКОВЫХ ЛЕСОВ ГОРЫ БЮКК И ВОСТОЧНОЙ ГЕРМАНИИ

А. СКАМОНИ

Автор сравнил буковые леса двух местностей и определил, что сходство дают в основном общие мезотрофные элементы. Буковые деревья горы Бюкк разделяют на южно-европейские, юго-восточно-европейские и континентальные элементы, и поэтому их можно считать самостоятельными ассоциациями. В противоположность этому буковые леса Восточно-Германского плейстоцена характеризуются субатлантическими и суббореальными элементами.

ность, которая зависит от степени разложения подстилки, от фенологических отношений леса (степень облиствения), а также от химического состава осадков и градации гусениц. На основе химического состава гравитационной воды можно определить миграцию отдельных биогенных элементов в почву. На основе данных по инпут и аутпут можно высчитать баланс питательных веществ почвы.

ПРОДУКЦИЯ ФИТОМАССЫ И УСЛОВИЯ ИСПОЛЬЗОВАНИЯ ЭНЕРГИИ В ТРАВЯНИСТОМ СООБШЕСТВЕ FESTUCO VAGINATAE-CORYNEPHORETUM НА ВНУТРЕННЕ-ШОМОДЬСКИХ КИСЛО-ПЕСЧАННЫХ ПОЧВАХ I

Э. КОВАЧ-ЛАНГ

Ранне начатое изучение продукции фитомассы на местности между Дунаем и Тиссой, на известковом песчано-степном травянистом сообществе в Чевхарасте, было продвинуто на Задунайские кислые песчано-степные травянистые сообщества. С марта до сктября 1977 года каждый месяц автор следила за 11 кусками почвенного монолита размером 20×20×2 см его подземной и надземной фитомассой, а также за изменением органического вещества почвы в травянистом сообществе. Количество и отношение фракций фитомассы показывает соответственное климатическим условиям отклонение по сравнению с известковыми песчаностепными травянистыми сообществами между Дунаем и Тиссой.

Во внутренней части комитата Шомодь, которая имеет гумидный климат, количество надземной фитомассы больше, а количество подземной меньше, а также меньше индекс важности корней, чем в семиаридском песчано-степном травянистом сообществе между Дунаем и Тиссой. Эффициэнция первичного продукта NET и подземных стоячих частей также выше, во внутренне-Шомодьском песчанно-степном травянистом сообществе.

РЕГИОНАЛЬНЫЕ ТИПЫ РАЗВИВАЮЩЕГОСЯ ЛЕСА, ОСОБЕННО НА ТЕРРИТОРИИ АЛЬП

Ф. КРАЛ

Автор разделяет на две зоны хвойные альпийские леса по их составу и постгладиальному развитию. Центрально-альпийскую хвойную лесную зону составляют Абиетета и Пицеета. Это подразделяется на две подзоны: в западно-альпийской зоне господствуют Абиететум, а в восточно-альпийской зоне Абиететум и Пицеетум правильно разделены на зоны. На краю Альп виды зоны *Abieti-Fagetum* делятся на некоторые типы (прованский, гельветический, верхне-итальянский, северно-альпийский, иллирский), между которыми имеются различия, показанные палинологическими методами в постгляциональной сукцессии.

DIGITALIS LANATA EHRH. В БУДАЙСКО-ПИЛИШСКИХ ГОРАХ

И. МАТЕ

Лекарственное растение *Digitalis lanata* Ehrh. разводится в Венгрии. Его нахождение в горах Пилиш вызывало споры, что не растет ли он как дикарь на этом месте? Опыты автора указывают на то, что это растение является членом естественного растительного сообщества. Это такой член балканско-паннонской флоры, который очень хорошо переносит культурное влияние.

ПИРОФИТИЧЕСКИЙ ПОЛУКУСТАРНИК В АФРИКАНСКИХ САВАННАХ: *GARDENIA SUBACAULIS* STAPF и HUTCH.

А. МЕДВЕЦКА-КОРНАШ

Автор изучала на постоянных квадратах адаптивные морфологические свойства *Gardenia subacaulis* Stapf и Hutch. в саваннах с ежегодно выжженной травой около Лусака (Замбия). *G. subacaulis* типичный геоксильный полукустарник, многолетний с

ПОТЕНЦИАЛЬНАЯ КАРТА ВЕГЕТАЦИИ В ДУНАЙСКОЙ ЧАСТИ МЕЖДУ РАЙКА И НАДЬМАРОШ

Т. ШИМОН, А. ХОРАНСКИ, Э. КОВАЧ-ЛАНГ

Авторы публикуют потенциальную карту вегетации местной части поймы Дуная, между Райка и Надьмарош. Эта работа стала актуальной в связи с осуществлением Габчиково—Надьмарош водного шлюза, чтобы зная динамические процессы потенциальной вегетации, можно было прогностицировать ожидаемые экологические изменения, которые будут появляться паралельно с изменением среднего уровня воды. В первой части работы авторы ознакамляют с картой потенциальной вегетации вместе с картированными единицами вегетации с их краткой характеристикой, а потом во второй части оценивают ожидаемые изменения экологических условий, т. е. предскажут в какой тип превратится настоящая растительность (напр. ивово-тополевая роша, вязево-ясенево-дубовая роша и т. д.) в результате повышения или понижения уровня воды.

К ВОПРОСУ ГЕОГРАФИЧЕСКОЙ ВЕГЕТАЦИИ ЕДИНИЦ ЛАНДЩАФТА

Х. ШЛЮТЕР

Цель географической вегетации является характеризование территорий Земли значительными типами вегетации регионализируя и классифицируя их в количественной последовательности. Однако для выработки иерархии вегетации местности синтаксономические категории растительных сообществ не применимы. Поэтому автор предлагает ввести термин «форма вегетации». Характеристика формы вегетации происходит с помощью сигекологических групп видов. Автор называет микроэлементы, составляющие формы вегетации «микро-фитохоры», и они соответствуют субассоциациям или географическим рассам. Мезо-фитохоры и макро-фитохоры означают более высокие вегетационно-географические уровни димензии.

УДОБРЕНИЕ ЛЕСОВ И ВЕГЕТАЦИЯ

И. СОДФРИДТ

Автор в течении десяти лет проводил опыты по удобрению насаженных тополевых лесов и искусственных хвойных лесов. Автор определил, что после 6-летнего удобрения не было замечено вредное влияние искусственного удобрения, которое могло бы привести лесной биоценоз к засорению. Таким образом удобрение лесов не ведет к загрязнению окружающей среды.

МЕСТОНАХОЖДЕНИЕ ЧЕРНОЙ СОСНЫ (*PINUS NIGRA* ARN.) РАССЫПАННОЕ НА ОКРАИНЕ ВОСТОЧНЫХ АЛЬП

Т. ВЕНДЕЛЬБЕРГЕР

Автор на основании экологических и ценологических критериев обсуждает аборигенность северо-восточного местонахоедения островками черной сосны. Автор установил, какой фонд черной сосны можно считать аборигенным и какой насаженным.

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A MAGYAR TUDOMÁNYOS AKADÉMIA BOTANIKAI KÖZLEMÉNYEI

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Acta Botanica Academiae Scientiarum Hungaricae, Tomus 26 (3—4), pp. 231—233 (1980)

IN MEMORIAM

dr. h. c. dr. Rezső Soó

(1903—1980)

The Editorial Board of Acta Botanica deeply regrets that with the death of Rezső Soó, ordinary member of the Hungarian Academy of Sciences, Hungarian scientific life suffered a great loss. The greatest figure of Hungarian botanical history, one of the most versatile masters of international botany and a most colourful personality of Hungarian scientific life has departed for ever.

His merits, scientific achievements have been acknowledged in the following words by Academician P. Jakucs at the funeral ceremony of Rezső Soó:

"*. . . Rezső Soó in Hungary was the first to recognize unequivocally that the investigation of not only plant individuals is necessary but that of the plant communities, the landscape forming associations. In Hungary he initiated the phytocenological science, directed his students to conduct regular researches of plant communities and at the same time to commence synecological works.*

MAGYAR TUDOMÁNYOS AKADÉMIA KÖNYVTÁRA

At the end of the twenties he finished his geobotanical monograph on the vegetation of Kolozsvár and analysed the composition of the terrestrial and water associations of the Balaton region. Later he studied the associations of Nyírség, the Plain beyond the river Tisza, Middle Transylvania and Székelyland. He studied in detail the Hungarian alkaline vegetation, beech-woods, the forests of the Sopron region (West-Hungary), the successional processes of the hydro- and psammoseres. During his studies of plant communities he prepared vegetation maps, microclimatic measures, analysed the areas of the Pannonian and Carpathic endemic and relic species, revealed the forest-steppe character of the Hungarian Plain and drew up the first floristic and vegetation maps of Hungary.

His earlier field works provided the foundaments for his later syntheses. In 1945 his "Növényföldrajz" (Plant Geography) appeared (since then it has been edited four times) and in 1951 in co-authorship with Sándor Jávorka he wrote "A Magyar Növényvilág Kézikönyve" (Manual of the Hungarian Plant Kingdom) and finally from 1964 to 1980 the six volumes of the Taxonomic Geobotanic Manual of the Hungarian Flora and Vegetation (also in Hungarian). The latter work comprising systematics, floristics, geobotany and ecology is a unique complex work unparalleled in Europe. Even countries much better studied than Hungary — such as Switzerland, France, Germany — could not accomplish such a synthesis — even in a creative teamwork — which Rezső Soó prepared alone. This huge work was written in Hungarian but other nations use and seek it in the world.

The phytocenologic researches and works of Rezső Soó and his students raised Hungarian geobotany to the European fore-front. However, the effect of this activity is much greater because these works laid the foundations for the environmental and nature protection aims of Hungarian ecological research. In the first part of the 20th century he initiated the process actually known as ecological sciences — arising from biological sciences — which instigates the whole of mankind to adopt a different attitude to nature. The essence of this development is to clearly assert that man is an inseparable part of his environment. In that environment, in which the initiating link of events is the plant, producing primary organic material and fixing sun energy. That vegetation whose structure, regulating role and functioning cannot be comprehended without preliminary study of plant associations. Perhaps this is the point at which Soó's lifework joins the actual questions of our days most intensively.

However, the geobotanical research was only one side of his botanical activity. All his life he worked continuously on the critical taxonomy of different plant families and genera (Alchemilla, Melampyrum, Rhinanthus, orchids etc.). He was particularly interested in the species rich Orchidaceae. In professional he was referred to as the "Pope of the orchids". He wrote a new phylogenetic system of the plant kingdom, titled "Növényrendszertan" (Plant Taxonomy) university textbook. His phylogenetic ideas have not only be propounded and taught in Hun-

garian schools but in the neighbouring, countries, too. For in his system heincluded all the modern results of those sciences, too (genetics, biochemistry, geobotany) without which up-to-date taxonomy is unheard of.

Numerous publications have appeared on botanical history, botanical gardens from environmental protection aspects (our first nature conservation areas in Hungary, the Nagyerdő of Debrecen, or the protection of Bátorliget were moved by him) and compiled major bibliographies, travel and congress reports and popular articles as well.

Rezső Soó was a real professor in founding a school. What was his secret? — He could discern very clearly from among his university students already in the first and second semesters, the exceptional talents and he could get them to join intensively in the work of his institute. At his department the light was never switched off before 11 o'clock at night.

On professional issues he was critical, demanding a high level, meanwhile, around him always prevailed an enthusiastic scientific atmosphere. He could make his students comprehend and could arouse their enthusiasm that revealing the Hungarian flora and vegetation and detecting the rule-like composition of its communities have to be carried out by Hungarian researchers at high level.

He directed his students in this goal and showed a good example with every activity of his. His incredible capacity for work became almost a legend evidenced by innumerable other social-scientific organizing work and museal collecting activity, which he carried on for the sake of Hungarian biology, botany and the whole Hungarian nation and of which we can only partly appreciate with his distinctions and international acknowledgements . . ."

*

Rezső Soó with his lifework left us with a great heritage which Hungarian botany proudly holds as its own and which it wishes to continue worthily. His work, scientific activity will always be an example to be followed.

Acta Botanica Academiae Scientiarum Hungaricae, Tomus 26 (3—4), pp. 235—247 (1980)

ANATOMICAL STRUCTURE OF THE VESSELS IN SOME TROPICAL CUBAN SPECIES BELONGING TO DIVERSE FAMILIES

By

K. BABOS

RESEARCH INSTITUTE FOR THE WOOD INDUSTRY, BUDAPEST, HUNGARY

(Received: 1 September, 1979)

This paper deals with the most important anatomical features of the vessels of 23 tropical species (tree and shrub) belonging to 21 diverse families. The species originate from Cuba, and 6 of the 23 species are endemic.

Material and method

The samples of the species came as an exchange material into the Research Institute for the Wood Industry from the Botanical Institute of the Cuban Academy of Sciences.

The blocks made from the diverse woods were softened in a BRINZER's autoclave at 2—3 atmospheres (in a mixture of 1 : 1 of water and glycerine). After the maceration transversal tangential and radial sections were made from the blocks. The tissue-macerations were made with the SCHULZE's method (SÁRKÁNY and SZALAI 1964). The sections were dyed with a 3% alcoholic solution of Toluidine blue and the macerations with a 5% aqueous solution of Methylene blue. The length of the vessels and the tangential and radial diameters of the vessels were measured. The characteristics of each species and their minima-maxima values were calculated from 100 measurements. The mathematical mean value ($\bar{x}$), the standard deviation of the mean value (s), the error deviation of the mean value (s_x) and the coefficient of variation of the mean value ($s_x\%$) were calculated from the length-values of the vessel elements of each species (SVÁB 1967). Appropriately magnified microphotographs were made from the sections and macerated samples. The species were listed and grouped into families on the basis of the Soó's Phylogenetical Taxonomy (1965). In this paper I used also the results published in my earlier studies dealing with the anatomy of the Cuban species (BABOS and VALES 1977; BABOS and BORHIDI 1978a, b).

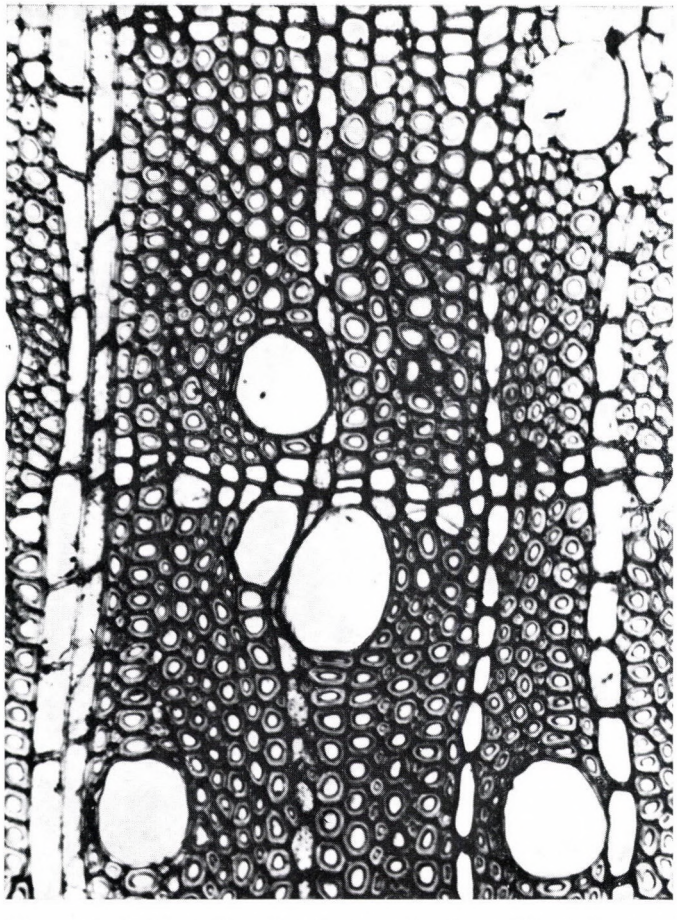
Results

The anatomical features of the vessels in the examined species and their minima-maxima and mean value are contained in Table 1. In the Table in parenthesis those characteristics of the vessels are given which according to METCALFE and CHALK are indicated as characteristic values of respective families genus (METCALFE and CHALK 1950).

According to our results the METCALFE and CHALK's data on the families and genus are only approximative values.

The mathematical characteristics of the length of the vessel elements are shown in Table 2.

Two species from each of the 23 species belong to one family, namely *Trichilia hirta* and *Guarea guidonia* belong to the *Meliaceae* family; *Catalpa punctata* and *Tabebuia lepidota*



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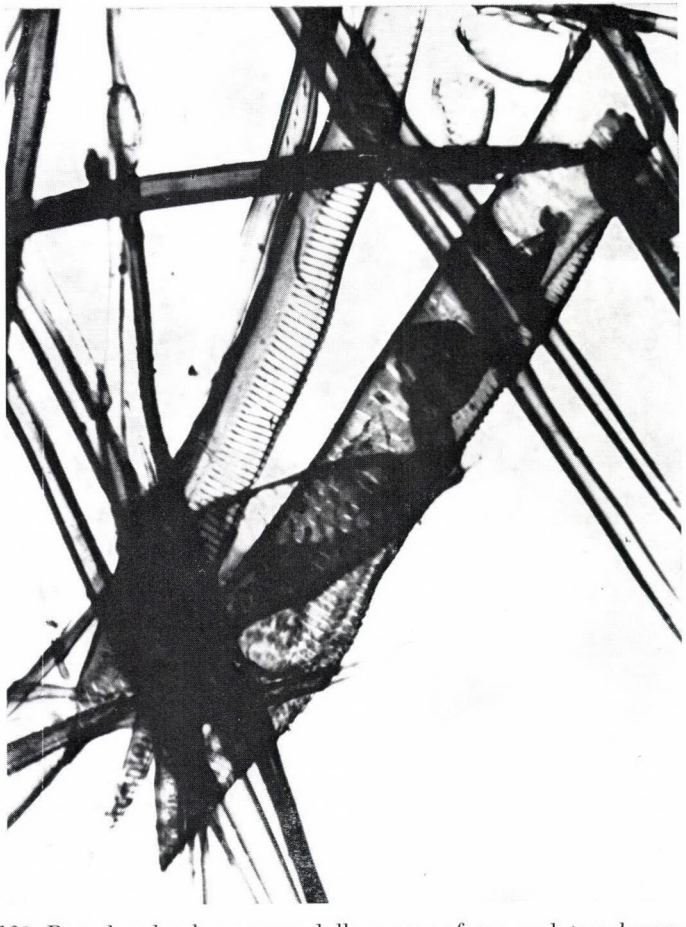

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Figures 1—2. Magnolia cubensis ssp. *cubensis.* — *Fig. 1.* Cross section. ×120. Round and valo pores medullary rays of one and two layers, terminal longitudinal parenchyma, wood fibres. *Fig. 2.* Macerated material, vessel members with a ladder-like oblonged pitted thickening and fibres. ×120

belong to the *Bignoniaceae* family. The vessel sizes of the species belonging to the *Meliaceae* and *Bignoniaceae* families are very different (see Table 1).

Arrangement of the vessels of each species in the xylem and the morphology of the vessel members:

Magnolia cubensis Urb. ssp. *cubensis* — *Magnoliaceae* (Figs 1, 2): the vessels sizes are small or medium. Diffused, generally solitary, sometimes in a radial group of 2—4 members. End of vessel members is oblique and both ends terminate in a long appendage.

Lysiloma bahamensis Benth. — *Mimosaceae*: Vessels sizes are medium or large. Diffused, usually solitary, rarely in a radial group of 2—4 members. End of vessel members is oblique; both ends terminate a long appendage.

Bucida ophiticola Bisse. — *Combretaceae*: Vessel size are small or medium. Diffused, solitary, sometimes in radial or irregular group of 2—4 members. End of vessel members is oblique and both ends terminate in a long appendage. These appendages can rarely attain the length of the vessel member.

Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq. — *Simaroubaceae*: Medium sized vessels. Diffused, generally solitary, but there are often irregular groups containing many members. End of vessel members is oblique, without appendage.

Trichilia hirta L. — *Meliaceae*: Small or medium sized vessels. Diffused, solitary, sometimes in a radial group of 2—5 members. End of vessel members is oblique and both ends terminate in a short appendage.

Guarea guidonia (L.) Sleumer. — *Meliaceae*: Medium or large sized vessels. Diffused, usually solitary or doubled. End of the wide vessel members is oblique, without appendage. The narrow vessel members terminate in a short appendage.

Cupania glabra Sw. — *Sapindaceae*: Small or medium size of vessels. Diffused, solitary, but sometimes in a radial group of 2—5 members. End of vessel members is oblique and both ends terminate in an appendage can often exceed half the length of the other vessel member.

Cyrilla racemiflora L. — *Cyrillaceae*: Small sized vessels. Diffused, usually solitary, sometimes in a radial group of 2—11 members. End of vessel members is oblique, and only one of the two ends terminate in an appendage.

Garrya fadyenii Hook. — *Garryaceae*: Small sized vessels. Diffused, exclusively solitary. End of the vessel members is oblique, both ends terminate in a short appendage.

Ceratopyxis verbenacea (Griseb.) Hook f. ex Hook. — *Rubiaceae*: Small sized vessels. Diffused, exclusively solitary. End of the vessel members is oblique, both ends terminate in a short appendage.

Bombacopsis cubensis A. Robyns. — *Bombacaceae* (Figs 3, 4): Medium or large sized vessels. Diffused, solitary, but often in a radial group of 2—3 members. End of the wide vessels is oblique, without appendage. One end of the narrow vessels terminates in an appendage exceeding half the length of the vessel.

Guazuma ulmifolia Lam. — *Sterculiaceae*: Small or medium sized vessels. Diffused, generally solitary, rarely in a group of 3—5 members. End of the vessel members is oblique, without appendage, one of the ends very rarely terminates in a short appendage.

Luehea speciosa Willd. — *Tiliaceae*: Small or moderately small sized vessels. Diffused, half ringporous. Solitary, sometimes in a radial group of 2—3 members. End of vessel members is oblique, without appendage, or both ends terminate in a short appendage.

Pera bumeliaefolia Griseb. — *Euphorbiaceae*: Medium or large sized vessels. Diffused, generally solitary, sometimes in a radial group of 2—6 members. End of the vessel members is oblique; one or both of their ends terminate in a short appendage.

Chionanthus bumelioides (Griseb.) Stearn — *Oleaceae*: Small sized vessels. Diffused, solitary, rarely in a radial group of 2—6 members. End of the vessel members is oblique and

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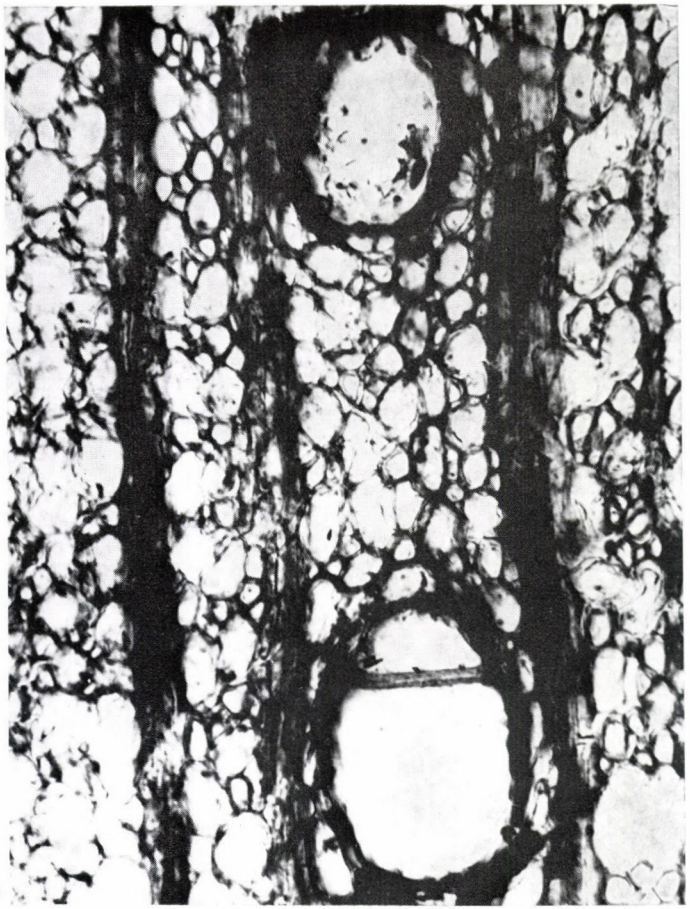

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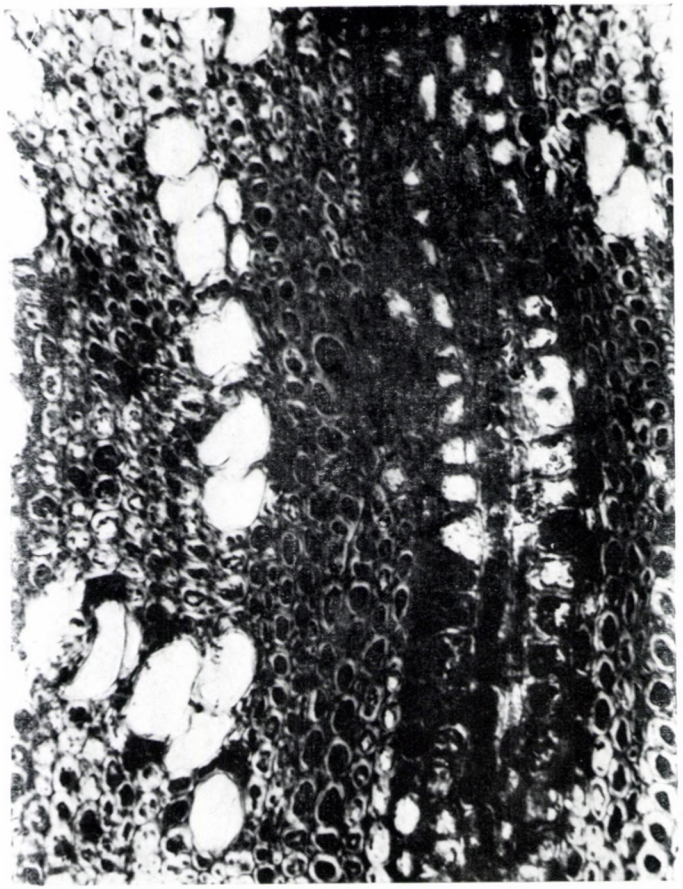
Figures 3—4. Bombacopsis cubensis. — *Fig. 3.* Cross section. ×120. Oval pores, medullary rays with one and several layers, apotracheal and contact vasicentric longitudinal parenchyma, wood fibres. *Fig. 4.* Macerated material, a typical vessel member with alternated pitted thickening and wood fibres. ×120



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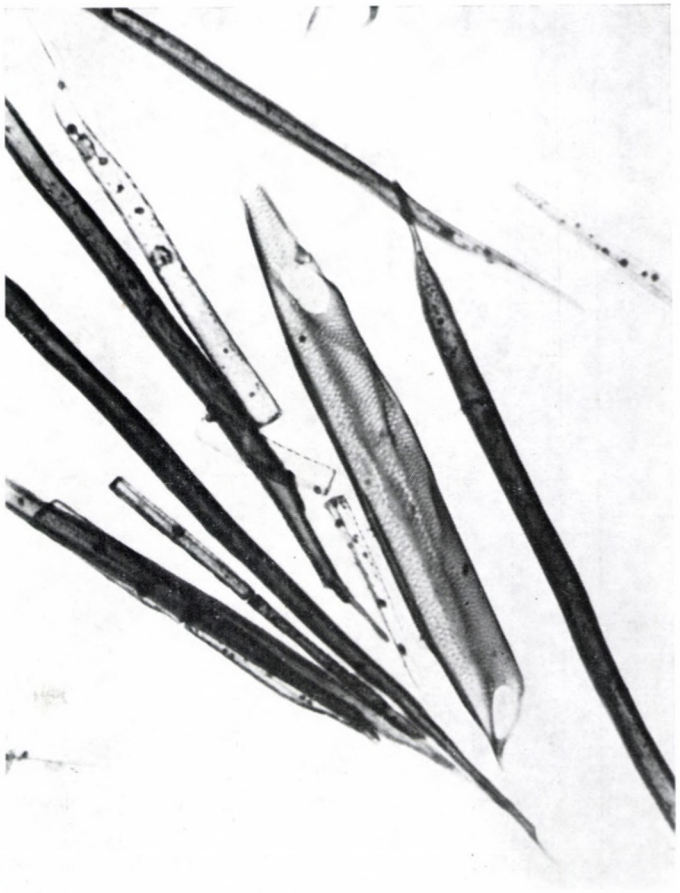

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Figures 5—6. Myrsine cubana. — *Fig. 5.* Cross section. ×120. Oval pores, medullary with several layers, scarce paratracheal and conract vasicentric longitudinal parenchyma, wood fibres. Dark mastic material in the medullary rays and in the cavity of the fibres. *Fig. 6.* Macerated material, typical vessel member with alternated small pitted thickening wood fibres, medullary ray cells and longitudinal parenchyma cells

Table 1

Anatomical features

Species, habitus	Characteristics of the		
	Shape	Number on 1 mm²	Tangential diameter, μm
Magnolia cubensis ssp. *cubensis* — Tree +	Round or oval	15 (5—100)	35.5—90.4 (< 100)
Lysiloma bahamensis — Tree	Oval or tangentially flattened	7 (5)	41.4—184.0 (100—200)
Bucida ophiticola — Tree +	Oval or tangentially flattened	17 (5—20)	42.6—92.3 (50—100)
Alvaradoa amorphoides ssp. *psilophylla* — Tree	Oval	54 (20)	20.7—69.0 (100—200)
Trichilia hirta — Tree	Round or oval	39	36.8—71.3 (50—200)
Guarea guidonia — Tree	Oval	9	64.4—165.6 (50—200)
Cupania glabra — Tree	Oval	18 (10—50)	23.0—108.1 (< 50)
Cyrilla racemiflora — Tree	Round or oval	46 (30—50)	25.3—71.3 (25—50)
Garrya fadyenii — Shrub	Oval, very small	69 (150)	18.4—52.9 (25—50)
Ceratopyxis verbenacea — Shrub +	Round or oval	84 (< 50)	20.7—52.9 (20—50)
Bombacopsis cubensis — Tree +	Oval	3 (< 5)	74.0—162.0 (200)
Guazuma ulmifolia — Tree	Oval or tangentially flattened	9 (1—5)	39.1—128.8 (100—200)
Luehea speciosa — Tree	Oval	28 (20—40)	28.4—82.8 (50—100)
Pera bumeliaefolia — Tree	Oval	7 (5 <)	46.0—184.0 (50—100)
Chionanthus bumelioides — Shrub	Oval or tangentially flattened	50 (20 <)	20.7—59.8 (25—100)
Cordia sebestena — Tree	Oval and round or tangentially flattened	11 (5)	46.0—126.5 (50—200)
Catalpa punctata — Tree	Oval or radially flattened	24 (5—20)	23.0—119.6 (100—200)

of the vessels

vessels and vessel members

Radial diameter, μm	Wall thickness, μm	Length of vessel member, μm	Intervascular pit	Perforation plate	Content material
49.7—142.2	1.8—3.6	479.0—1587.0 (800—1100)	Scalariform opposed with halo	Ladder-like	
20.7—181.7	4.6—13.8	213.0—426.0 (200—400)	Alternated, small with halo	Simple	Resin
32.2—94.3	2.3—6.9	575.0—1299.0 (300—500)	Alternated, adorned, with halo	Simple	Resin
23.0—62.0	2.3	142.0—568.0	Oblong with halo	Simple	Rarely resin
46.0—96.6	2.3—6.9	355.0—923.0	Adorned with halo	Simple	Resin
57.5—209.3	2.3—9.2	149.0—805.0 (300—700)	Oblong with halo	Simple	—
23.0—121.9	2.3—6.9	568.0—1136.0 (200—700)	Alternated small, with halo	Simple	—
20.7—57.5	2.3—6.9	213.0—639.0 (800)	Small, opposed, with halo	Simple	—
23.0—57.5	2.3—4.6	355.0—1065.0 (600)	Very rare, with halo	Ladder-like	—
20.7—55.2	2.3—6.9	414.0—1092.0 (500—1300)	Alternated, small, margined	Simple	—
102.3—190.6	1.8—2.7	218.0—598.0 (300—800)	Polygonal margined with halo	Simple	Resin
39.1—174.8	2.3—6.9	284.0—497.0 (200—400)	Scalariform oblonged with halo	Simple	Rarely resin
20.7—115.0	2.3—9.2	142.0—568.0 (260—450)	Small with halo	Simple	Resin
68.5—264.0	4.6—11.5	781.0—1065.0 (300—850)	Polygonal with halo margined	Simple	Resin
20.7—73.6	2.3—6.9	284.0—639.0 (200—600)	Small with halo	Simple	Thyllis and resin
32.2—133.4	2.3—9.3	213.0—355.0 (150—500)	Alternated, small with halo	Simple, rarely bordered	Rarely resin
29.9—81.5	2.3—4.6	284.0—852.0 (200—420)	Oblong with halo	Simple	—

Species, habitus	Characteristics of the ves-		
	Shape	Number on 1 mm²	Tangential diameter, μm
Tabebuia lepidota — Shrub	Round or oval	47 (5—20)	25.3—92.0 (50—100)
Curatella americana — Shrub	Round or tangentially flattened	3 (1—8)	86.7—165.6
Calophyllum antillanum — Tree	Oval	9 (5)	52.9—163.3 (100—200)
Myrsine cubana — Shrub +	Oval	49 (20—40)	27.6—69.0 (50—100)
Mastichodendron foetidissimum — Tree	Oval or tangentially flattened	28 (5)	18.4—82.8 (100—200)
Quercus oleoides ssp. *sagraeana* — Tree +	Round or oval, sometimes tangentially flattened	11 (2—9)	36.8—138.0 (50—100)

both ends terminate in an appendage. Length of an appendage can achieve a third of the length of the vessel.

Cordia sebestena L. — *Boraginaceae*: Vessel from small to large sizes. Diffused, half ring-porous. Solitary, sometimes in an irregular group of 2—3 members. End of the wide vessel members is straight, without appendage. End of the narrow vessels is oblique, both ends terminate in an appendage. Length of an appendage can attain one third of the length of the vessel.

Catalpa punctata Griseb. — *Bignoniaceae*: Small or medium sized vessels. Diffused, generally solitary, sometimes in an irregular group of 2—4 members. End of the wide vessel member is oblique, without appendage. One end of the narrow vessels terminates in an appendage exceeding one third of the length of the vessel.

Tabebuia lepidota (H.B.K.) Britt. — *Bignoniaceae*: Small or moderately small sized vessels. Diffused, solitary or in a radial group of 2—4 members. End of the vessel members is oblique, without appendage. One of their ends rarely terminates in a short appendage.

Curatella americana L. — *Dilleniaceae*: Medium sized vessels. Diffused, exclusively solitary. End of the vessel members is oblique; both ends terminate in a short appendage.

Calophyllum antillanum Griseb. — *Guttiferae*: Medium sized vessels. Diffused, generally solitary, but occasionally in an irregular group of 2—4 members. End of the vessel members is oblique, and only one end terminates in a short appendage.

Myrsine cubana A. DC. — *Myrsinaceae* (Figs 5, 6). Small or moderately small size of vessels. Diffused, solitary, but sometimes in a radial or irregular group of 2—5 members. End of vessel members is oblique; both ends terminate in a short appendage.

Table 1 (cont.)

sels and vessel members

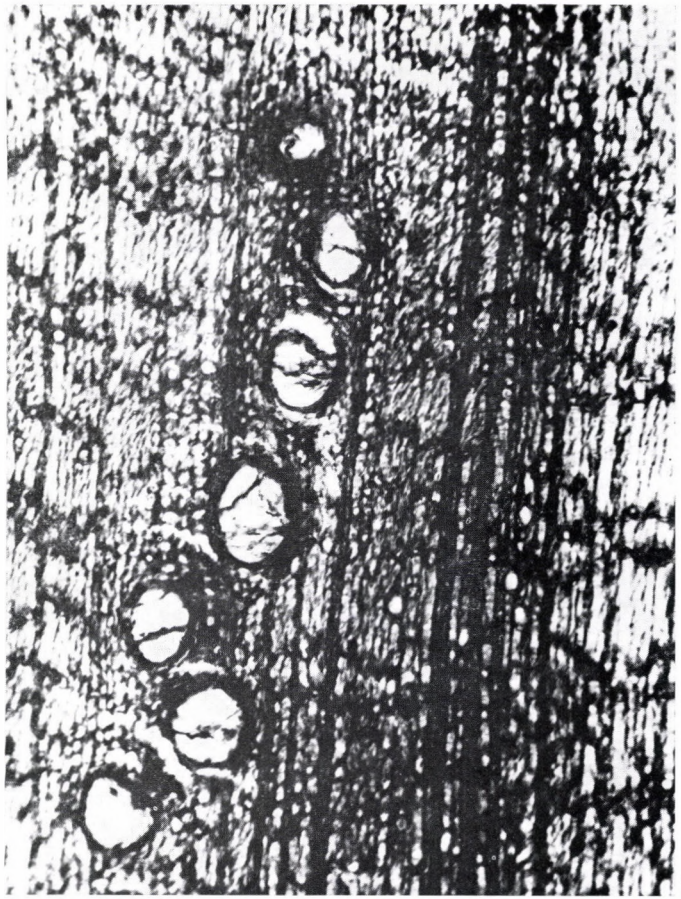
Radial diameter, μm	Wall thickness, μm	Length of vessel member, μm	Intervascular pit	Perforation plate	Content material
34.5—96.6	2.3—6.9	213.0—426.0 (200—420)	Opposed oblonged with halo	Simple	—
34.5—133.4	2.3—11.5	426.9—1065.0 (400—1000)	Scalariform, oblong with halo	Simple	Thyllis
50.6—234.6	2.3—6.9	284.0—781.0	Margined, very small with halo	Simple	Resin
41.4—73.6	2.3	284.0—781.0 (200—500)	Alternated, small with halo	Simple	Resin
34.5—82.8	2.3—6.9	568.0—781.0 (500—700)	Alternated, small with halo	Simple	—
34.5—161.0	2.3—6.9	355.0—781.0 (400—800)	Alternated, with halo	Simple	Thyllis rarely resin

Species marked with + are exclusively found in Cuba, i.e. they are endemic

Data in parentheses are minima-maxima values in METCALFE and CHALK's study, concerning the families, genera and rare species (e.g. *Cyrilla racemiflora*)

Mastichodendron foetidissimum (Jacq.) Cronquist. — *Sapotaceae*: Small or medium sized vessels. Diffused, generally solitary, sometimes in a radial group of 3—4 members. End of vessel members is oblique, and both ends terminate in a short appendage.

Quercus oleoides C. et S. ssp. *sagraeana* (Nutt.) Borhidi. — *Fagaceae* (Figs 7, 8): From small to medium sized vessels. Diffused, generally solitary, rarely doubled. The vessels show an arrangement resembling a tongue of flame in the xylem. End of wide vessels is oblique, without appendage. Both ends of the narrow vessels terminate in a short appendage.



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8

Figures 7—8. Quercus oleoides ssp. *sagraeana.* — *Fig. 7.* Cross section. ×120. Oval and round pores in an arrangement resembling a tongue of flame, accumulated medullary rays with one layer, apotracheal metting longitudinal parenchyma, wood fibres. *Fig. 8.* Macerated material, on one side with a wide vessel member ending in appendage, alternated small pitted thickening and wood fibres. ×120

Table 2

Mathematical characteristics of the length of vessel elements

Species	$\bar{x}$ μm	$\pm s$ μm	$s_{\bar{x}}$ μm	$s_{\bar{x}}$%
Magnolia cubensis ssp. *cubensis*	616.22	90.92	87.43	14.18
Lysiloma bahamensis	291.80	69.92	45.83	15.70
Bucida ophiticola	576.52	139.49	57.97	10.05
Alvaradoa amorphoides ssp. *psilophylla*	347.70	111.13	54.22	15.59
Trichilia hirta	596.40	120.90	54.22	9.09
Guarea guidonia	453.00	134.16	62.05	13.69
Cupania glabra	768.00	114.70	79.20	10.31
Cyrilla racemiflora	866.80	102.64	61.48	7.09
Garrya fadyenii	656.00	205.28	70.99	10.82
Ceratopyxis verbenacea	317.00	76.48	53.74	16.95
Bombacopsis cubensis	374.00	80.07	48.79	13.04
Guazuma ulmifolia	314.40	60.80	45.83	14.57
Luehea speciosa	388.80	101.90	58.03	14.92
Pera bumeliaefolia	541.00	86.81	49.05	9.06
Chionanthus bumelioides	471.10	119.86	54.22	11.50
Cordia sebestena	277.50	49.75	40.99	14.77
Catalpa punctata	425.80	117.74	76.90	18.06
Tabebuia lepidota	300.30	54.07	45.83	15.26
Curatella americana	628.00	121.90	57.97	9.23
Calophyllum antillanum	628.85	104.54	88.71	14.10
Myrsine cubana	540.80	135.27	57.97	10.71
Mastichodendron foetidissimum	639.00	48.67	75.39	11.78
Quercus oleoides ssp. *sagraeana*	507.00	69.31	78.71	15.52

Summary

The following conclusions can be drawn: among the studied 23 species

— in the study of METCALFE and CHALK the vessel sizes relating to the respective families and genera are only approximative values;

— vessel sizes of the species belonging to the same family are very different;

— the longest vessel member is to be found in *Magnolia cubensis* ssp. *cubensis* (1587 μm), the shortest one is in *Alvaradoa amorphoides* ssp. *psilophylla* and in *Luehea speciosa* (142 μm);

— a ladder-like thickening of the cell wall can be seen only in the *Magnolia cubensis* ssp. *cubensis*;

— the perforate plate of the vessel members is generally simple, excluding *Magnolia cubensis* ssp. *cubensis* and *Garrya fadyenii*, where the perforate plate is ladder-like, in *Cordia sebestena* the perforated plate is rarely bordered;

— end of the vessel members is without appendage or terminating in a short appendage. This appendage can exceed one third or half of the length of the vessel member in *Cupania glabra*, *Bombacopsis cubensis*, *Chionanthus bumelioides*, *Cordia sebestena*, *Catalpa punctata*.

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SEASONAL CHANGES IN THE REDUCING ORGANIC MATERIALS OF SHRUB LEAVES*

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In connexion with the topics of the complex ecological research of "Síkfőkút Project" in Hungary, the paper describes the seasonal dynamics in 1978 of the reducing organic materials occurring in the leaves of the four dominant shrub species of *Quercetum petraeae-cerris* forests. Further the investigations covered the effect of the temperature, quantity of precipitation, hours of sunshine on the days preceding the samplings on these materials. According to the results, in the case of *Cornus mas*, *Acer campestre* and *Acer tataricum*, temperature has a primary effect on the formation of carbohydrates, and precipitation influences considerably only the quantity of free, easily mobilizable saccharides. The accumulation of the reducing materials in *Ligustrum vulgare* is on the other hand influenced primarily by the quantity of precipitation. The number of hours of sunshine and the temperature formation have a strong effect on the quantity of phenols and polyphenols. In springtime, these materials are to be found in much greater quantities in those shrubs which are less affected by phytophagous organisms.

Introduction

The part processes known from natural environments and communities by means of the complex biotic and abiotic factors can provide information on the organizational questions of the whole living community. We have, however, very little knowledge of the distribution and dynamics of organic compounds within associations. The carbohydrate studies for example, have assumed geater intensity only after the initiation of IBP and MAB programmes (ZIMMERMANN 1957, PARKER 1960, KASHIWIDA 1963, JEREMIAS 1964, 1969, GÖRING 1970, DIMANTOGLOU and MELETIOU-CHRISTOU 1977, 1978, etc.). These researches investigated the seasonal courses of courses of carbohydrates in the leaves of plants living in natural associations, but certain studies also tried to find a correlation between the changes in some climatic factors (for example, temperature, and precipitation) and in carbohydrate contents.

In this study, we have tried to follow the seasonal changes — during the vegetation period — by the accumulation of the reducing organic materials found in the leaves of the four most frequently occurring and dominant shrub species of the zonal *Quercetum petraeae-cerris* forests of Northern-Hungarian hill regions that is, in the sampling areas of MAB-project ecological investigations of Hungary (see "Síkfőkút Project"; JAKUCS 1978). We have tried to correlate the results with the effect of phytophagous heterotrophic organisms (biotic factor), and – among the climatic factors – of the amount of precipitation, temperature and hours of sunshine (abiotic factors).

* Síkfőkút Project, No. 56.

Material and method

Sampling

Samples were taken in the spring of 1978, during intensive growth more frequently, then only monthly, on the same days, using the following shrub species: *Acer campestre*, *A. tataricum*, *Ligustrum vulgare*, *Cornus mas*. Five samples were examined from each species, and the same samples were used in the course of the whole experiment. When collecting the leaves care was taken so that the specimen would represent the average leaf of the shrub; 50 leaves were taken from each shrub at a time. The time of sampling were as follows: 17 May, 25 May, 14 June, 30 June, 27 July, 30 August, 14 September, and 12 October.

Chemical analyses

The leaves were dried at 85 °C to weight constancy, then grouned to the fineness of flour; the samplings collected from the five individuals of the same species were mixed together and the chemical analysis was carried out with this material.

To determine the reducing organic materials, the micro-School method was used (DEMECZKY and JENEY 1958), since in this way information could be obtained on the quantity of other reducing organic materials (primarily phenols and phenol derivatives) occurring besides carbohydrates. The differentiation of carbohydrates was carried out also by anthrone reaction (KOECHLER 1952, PÁNCZÉL and EIFERT 1961).

Four fractions were separated during the differentiation. Fraction A indicates the quantity of free reducing materials without hydrolysis, Fraction B the quantity of the total reducing material after hydrolysis, Fraction C the quantity of free saccharides, while Fraction D the quantity of total reducing carbohydrate after hydrolysis.

Results and evaluation

Seasonal changes in the reducing materials

As regards the various shrub species, the seasonal changes in the reducing materials are demonstrated in Fig. 1. I—IV. There are considerable differences not only in the quantities but also the course of vegetation periods. The differences are mainly attributable to inheritable characteristics of the species (WANNER 1958), and in connexion with this, to that an identical environment can have different effects on certain species (JEREMIAS 1964, 1969; MOONEY and HAYS 1973).

Considering the seasonal changes shown in the figures, it is remarkable that in the case of *Ligustrum vulgare* the value of accumulation was outstandingly high in relation to the reducing materials at springtime, while remarkably low values occurred with *Acer campestre*. Since among the reducing organic materials phenols and phenol derivatives have probably an inhibitory effect on the intensity of feeding in the phytophagous heterotrophs (FEENY 1968, 1967; BÉRES 1979), the different quantites of the reducing organic materials can partly explain the different extent of phytophagous damage in

the two shrub species. According to the data of SZABÓ and MARES (1978; for 1978: SZABÓ ex verb.), the *Acer* species are the most damaged shrubs of the forest, while *Ligustrum* is the least damaged shrub. However, the accumulation of this material cannot be linked with respect to prevention of shrubs damaged by caterpillars feeding on them. For example, in the data of *Cornus mas* and

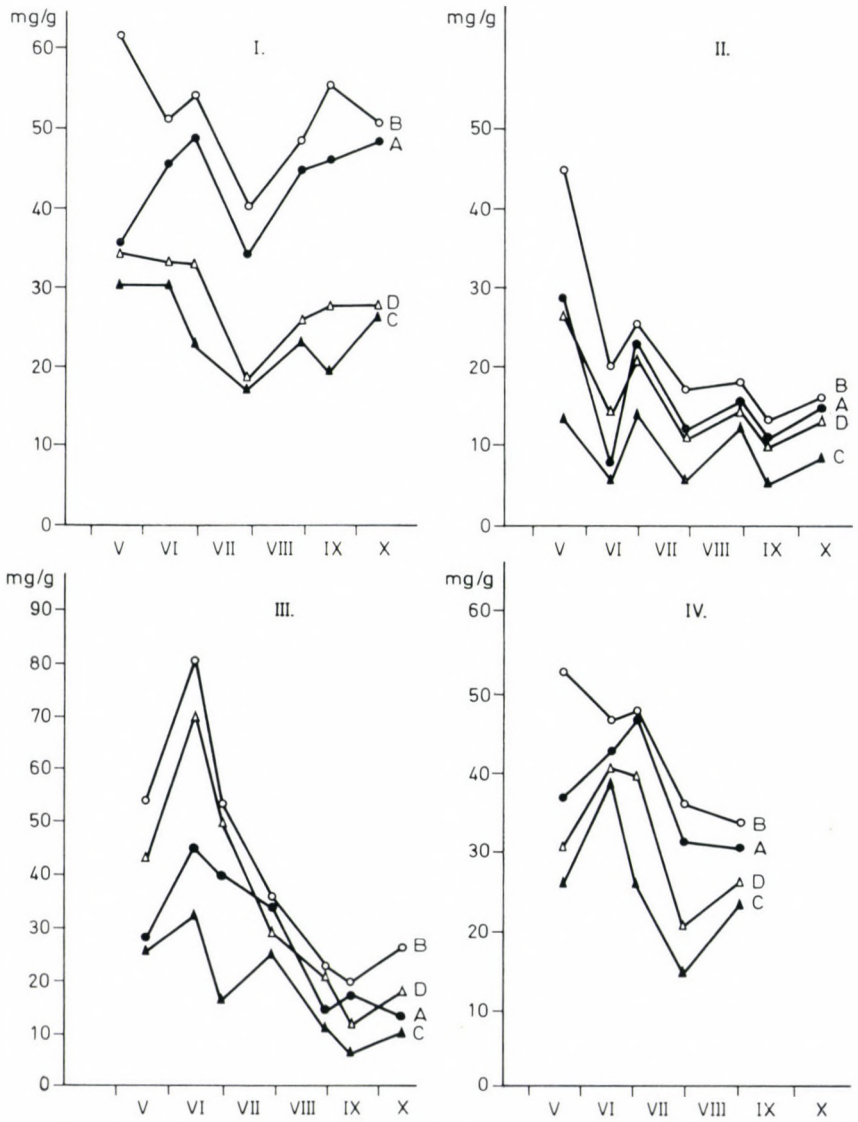

Fig. 1. Seasonal changes in the reducing materials. I = *Cornus mas*, II = *Acer campestre*, III = *Ligustrum vulgare*, IV = *Acer tataricum*; A—D = for explanation see Table 1

Acer tataricum there is not such so a great difference in the accumulation of these materials as in the damage caused by the two shrub caterpillars.

In the autumn months, the carbohydrate content of *Cornus mas* is the highest. The greatest fluctuation in accumulation in the course of the vegetation period was measured in *Ligustrum vulgare* while the smallest fluctuation in *Acer campestre*. In this shrub, also the maximum and minimum time periods differ compared with the other three shrubs examined.

The effect of certain climatic factors on the changes in the quantity of reducing materials

According to JEREMIAS (1964), temperature has the greatest influence on the carbohydrate content of Central European plants. In our experiment, we also examined, in addition to temperature, the quantity of precipitation and the number of sunlit hours in order to find their positive or negative effect.

Of course several other factors can be important in relation to the carbohydrate dynamism of the plant, however, on a supraindividual level the factors emphasized by us seem to be of decisive importance from the ecological aspects. The data — as yet available only in MS — obtained from constant measurements in the research area were used for the climatic factors.

The correlation coefficient (r) between the two variables was calculated by supposing a linear relationship between the climatic factors mentioned and the carbohydrate content. Moreover, relationship between the weather before the sampling days and the carbohydrate content changing with the increase in the number of days before the sampling was also studied. This also means that the weather was considered for longer periods. On the basis of our preliminary studies, the weather of the two or five days preceding the sampling can be used in the analysis. By increasing the number of days preceding the sampling, no significant difference was found compared with the five days. The values of the correlation coefficient are contained in Table 1.

With *Ligustrum vulgare*, no correlation can be detected between the temperature and the changes in the accumulation of reducing materials compared with the other three shrub species examined as for *Acer tataricum*, the temperature of the preceding two days seems to be decisive. This shrub shows a quick reaction of the carbohydrate content to the changes in temperature. A more lasting high temperature is favourable for the formation of polyphenols. Similar results were obtained in *Cornus mas*, but the correlation was stronger. With greater drops in temperature, there was a decline in the carbohydrate content in each case. In *Acer campestre*, the evenly high temperature of the longer period seems to be decisive, with the exception of the easily mobilizable free saccharide fraction, which reacts quickly to the changes in temperature.

Table 1

Correlation coefficients in the climatic factors and the fractions of the reducing materials

	Cornus mas				*Acer campestre*			
	A	B	C	D	A	B	C	D
2 days' temperature	0.410	0.922	0.499	0.870	0.471	0.530	0.647	0.662
5 days' temperature	0.240	0.871	0.593	0.667	0.776	0.904	0.553	0.831
2 days' precipitation	0.123	0.479	0.787	0.782	0.203	0.614	0.151	0.567
5 days' precipitation	0.088	0.240	0.665	0.599	0.205	−0.234	0.148	0.197
2 days' number of hours of sunshine	0.110	0.765	0.164	0.654	0.376	0.474	0.239	0.600
5 days' number of hours of sunshine	0.202	0.731	0.264	0.709	0.133	0.354	−0.032	0.362
	Ligustrum vulgare				*Acer tataricum*			
	A	B	C	D	A	B	C	D
2 days' temperature	0.153	−0.158	0.243	0.155	0.551	0.664	0.478	0.602
5 days' temperature	−0.202	0.184	0.114	0.118	0.109	0.724	0.164	−0.147
2 days' precipitation	0.681	0.934	0.770	0.898	0.594	0.834	0.827	0.718
5 days' precipitation	0.725	0.926	0.715	0.902	0.599	0.568	0.925	0.769
2 days' number of hours of sunshine	0.517	0.477	0.168	0.463	0.862	0.909	0.351	0.702
5 days' number of hours of sunshine	0.126	0.480	0.155	0.446	0.854	0.956	0.687	0.848

A = quantity of the reducing material without hydrolysis, B = quantity of total reducing material after hydrolysis, C = free saccharides, D = quantity of total reducing carbohydrate after hydrolysis

The quantity of precipitation in *Ligustrum vulgare* has a strong influence upon that of the materials. However, no correlation could reducing materials. However, no correlation could be detected with the precipitation that had fallen 10 days before the sampling, therefore, it is presumable that in this shrub the reducing materials quickly react to precipitation. At the time of dryness, there is a rapid decrease in carbohydrate content as indicated by the summer minimum value. There is a close correlation between precipitation and the quantity of reducing materials in *Acer tataricum*. Here also, the water supplied state seems to be one of the most important conditions of carbohydrate production. The precipitation preceding the sampling in *Cornus mas* caused an immediate change in the saccharide fraction; here, however, precipitation had only a slight influence on the changes in the quantity of phenols and polyphenols.

A correlation between the number of hours of sunshine and the reducing materials, can be supposed in *Acer tataricum* and *Cornus mas*. Sunshine also has an influence mainly on the formation of phenols and polyphenols.

The order of importance in the effect of climatic factors examined

The relationship between the individual climatic factors and the carbohydrate content is not completely described by the correlation coefficient, for in each case the relationship was only between two parameters as if they could have affected the variable parameter independently of each other. In reality, the relationships are much more complicated. "By applying the path analysis,

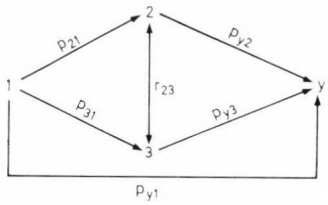

Fig. 2. Path diagram: — 1 = quantity of precipitation (mm), 2 = temperature (°C), 3 = number of hours of sunshine, y = variable parameter in a given case; r = correlation coefficient; p = path coefficient

we make an attempt to explore the affecting factors, and to break down the correlation coefficient into its components in a way that we allow relationships between the independent variables in the network of relationships." (PRÉCSÉNYI and BÁRDOS 1974.)

As a first step a diagram was constructed (Fig. 2), which shows the relationships between the independent variables. According to our hypotheses, precipitation has a direct effect on the changes in the carbohydrate content, and also its indirect effect prevails through the changes in temperature and the number of hours of sunshine. Temperature has a direct effect on the carbohydrate content and also its indirect effect prevails through the number of hours of sunshine. The influence of the number of hours of sunshine is similar to this.

On the basis of the path values (Table 2) it can be stated that in the case of *Cornus mas* it is temperature that has the greatest influence upon the variance of carbohydrate content, whether considering either the shorter period preceding the sampling, or the longer one. The influence of temperature is especially decisive in the case of the total reducing saccharides occurring after hydrolysis. Precipitation has at least as great an influence upon the free saccharide fraction as has temperature.

In *Acer campestre*, temperature again has a decisive role. Here however, it primarily determines the quantity of free saccharides. The quantity of polysaccharides is influenced towards a positive direction only by longer, lasting and steady temperature.

Table 2

Path values in the examination of the relationships between individual shrub species and the climatic factors
(for explanation see Table 1 and Fig. 2)

	Fraction C			Fraction D		
	P_{y1}	P_{y2}	P_{y3}	P_{y1}	P_{y2}	P_{y3}
Cornus mas						
2 days	0.628	0.622	−0.207	−0.354	0.745	0.209
5 days	0.449	0.676	−0.139	0.185	0.378	0.484
Acer campestre						
2 days	−0.065	0.783	−0.228	0.200	0.471	0.319
5 days	0.062	0.891	−0.563	−0.021	0.953	−0.362
Acer tataricum						
2 days	0.596	0.417	0.102	0.318	0.285	0.532
5 days	0.609	−0.380	0.913	0.261	0.555	0.517
Ligustrum vulgare						
2 days	0.656	0.223	0.035	0.678	0.188	0.575
5 days	0.631	0.034	0.135	0.696	−0.229	0.582

The temperature two days before sampling in *Acer tataricum* brought about changes in the accumulation of free saccharides, together with precipitation. Their direct effect on this fraction is uniform. Considering a shorter period it is again the above two factors that have a decisive influence upon the changes in the quantity of polysaccharides; however, if a longer period is considered, their determining role is taken over by the number of hours of sunshine.

In the *Ligustrum vulgare* shrub, precipitation has a decisive role in the changes in the quantity of reducing materials.

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NEW NAMES AND NEW SPECIES IN THE FLORA OF CUBA, II

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A list of necessary nomenclatural changes concerning the flora of Cuba, some new combinations and new names are reported. New combinations are: *Schizachyrium reedii* (Hitchc. et Ekm.) Borhidi et Catasus, *Schizachyrium parvifolium* (Hitchc.) Borhidi et Catasus, *Garcinia aristata* (Griseb.) Borhidi, *Garcinia bakeriana* (Urb.) Borhidi, *Garcinia cincta* (Urb.) Borhidi, *Garcinia cubensis* (Borhidi) Borhidi, *Garcinia moaensis* (Bisse) Borhidi, *Garcinia ophiticola* (Borhidi) Borhidi, *Garcinia polyneura* (Urb.) Borhidi, *Garcinia revoluta* (Urb.) Borhidi, *Garcinia ruscifolia* (Griseb.) Borhidi, *G. ruscifolia* var. *linearis* (Borhidi) Borhidi, *Chionanthus acunae* (Borhidi et Muñiz) Borhidi, *Chionanthus moncadae* (Borhidi et Muñiz) Borhidi, *Chionanthus bumelioides* (Griseb.) Stearn ssp. *obovalis* (Borhidi et Muñiz) Borhidi, *Micromeria suborbicularis* (Alain) Borhidi, *Isidorea ophiticola* (Borhidi) Borhidi et Moncada, *Isidorea acunae* (Borhidi) Borhidi et Moncada. New names are: *Terminalia bipleura* nom. nov., *Garcinia clarensis* nom. nov., *Garcinia pungens* nom. nov., *Garcinia serpentini* nom. nov. Five new taxa of the family *Rubiaceae* are also described: *Isidorea microphylla* sp. n., *Schmidtottia monticola* sp. n., *S. shaferi* ssp. *neglecta* ssp. n., *S. elliptica* ssp. *oblongata* ssp. n., and *S. cucullata* Borhidi et Bisse sp. n.

Introduction

Recent taxonomical results concerning the flora of the Caribbean regions, especially the third volume of the excellent Flora of the Lesser Antilles of R. A. HOWARD — with the collaboration of outstanding specialists, as F. W. GOULD (*Poaceae*), T. KOYAMA (*Cyperaceae*), P. J. MAAS (*Burmanniaceae, Cannaceae, Zingiberaceae*) and R. W. READ (*Arecaceae*) —, and some important monographic studies (e.g. AIELLO, GOULD, GOULD and CLARK, KOYAMA, LIPPOLD, KING and ROBINSON, DAVIDSE, etc.) suggested to make necessary corrections in the use of names for the flora of Cuba.

In order to have a comprehensive general view of the dispersed and separately, parallelly studied floras of the West Indies, first of all, a unified, well based concept of nomenclature and taxonomic ranking is requested. The Flora of the Lesser Antilles can be considered as a base for unifying concepts in the use of names, in forming generic and species concepts etc. for the other Flora works in preparation in the Greater Antilles (New Flora of Cuba, Flora of Hispaniola). The present series of papers is destinated to contribute some data to the mentioned general view based on Cuban plant materials.

Najadaceae

Najas guadelupensis (Spreng.) Morong = **Najas guadelupensis** (Spreng.) Magnus

Hydrocharitaceae

Hydromystria stolonifera G. F. W. Meyer = **Limnobium stoloniferum** (H. et B.) Morton
Thalassia testudinum Banks et Soland. ex König (correction of the author's name)

Poaceae

Bambusa vulgaris Schrad. ex Wendl. (corr. author's name)
Eragrostis cilianensis (All.) E. Mosher (corr. author's name)
Eragrostis tephrosanthos Schult. = **E. tephrosanthes** Schult.
Eragrostis domingensis (Pers.) Steud. = **E. prolifera** (Sw.) Steud.
Leptochloa domingensis (Jacq.) Trin. = **L. virgata** (L.) Beauv.
Leptochloa panicea (Retz) Ohwi sensu Alain Suppl. Flora de Cuba 1969: 9 = **L. filiformis** (Lam.) Beauv.
Lasiacis maculata (Aubl.) Urb. sensu Alain in Suppl. Fl. Cuba = **L. sorghoidea** (Desv.) Hitchc. et Chase
Lasiacis grisebachii (Nash) Hitchc. is represented by two varieties: var. **grisebachii** and var. **lindleieana** Davidse (Ann. Missouri Bot. Gard. **64:** 375, 1978); based on the type: EKMAN 13530, Habana, Lomas de Camoa. Endemic to the provinces Pinar del Rio, Habana and Matanzas.
Sporobolus jacquemontii Kunth is a valid species. It can be distinguished from *S. indicus* (L.) R. Br. by the following key:
— Second glume usually half or more as long as the spikelet, panicle branches short, appressed, the inflorescence usually interrupted-spicate in appearance ... *S. indicus*
— Second glume less than half as long as spikelet; panicle branches well developed, slender, losely erect or spreading ..... *S. jacquemontii*

Sporobolus poiretii (Roem. et Schult.) Hitchc. = **S. indicus** (L.) R. Br.
Chloris barbata (L.) Sw. = **Chloris inflata** Link
Chloris petraea Sw. = **Eustachys petraea** (Sw.) Desv.
Bouteloua heterostega (Trin.) Griffiths = **Bouteloua repens** (HBK.) Scribn. et Merr.

Panicum L.

An update trend is the taxonomic segregation of the genus *Panicum* into several genera as: *Brachiaria* Griseb., *Dichanthelium* (Hitchc. et Chase) Gould, *Paspalidium* Stapf. etc. For the Cuban species formerly treated as *Panicum*, the following changes are suggested:
Panicum molle Sw. = **Brachiaria mollis** (Sw.) Parodi
Panicum reptans L. = **Brachiaria reptans** (L.) Gard. et C. E. Hubb.
Panicum adspersum Trin. = **Brachiaria adspersa** (Trin.) Parodi
Panicum fasciculatum Sw. = **Brachiaria fasciculata** (Sw.) S. T. Blake
Panicum echinulatum Mez = **Brachiaria echinulata** (Mez) Parodi
Panicum purpurascens Raddi = **Brachiaria purpurascens** (Raddi) Henr.
Panicum geminatum Forssk. = **Paspalidium geminatum** (Forssk.) Stapf
Panicum condensum Nash in Small = **Panicum rigidulum** Nees
Panicum boliviense Hack. = **Panicum laxum** Sw.

According to GOULD (1974), CLARK and GOULD (1975), BROWN and SMITH (1975), GOULD and CLARK (1978) etc. *Panicum* L. subgenus *Dichanthelium* Hitchc. et Chase 1910 is to be considered as a separate genus by the name: **Dichanthelium** (Hitchc. et Chase) Gould and the following nomenclatural changes are due for the Cuban taxa:

Panicum xalapense HBK. and *P. laxiflorum* Lam. = **Dichanthelium laxiflorum** (Lam.) Gould

Panicum polycaulon Nash = **Dichanthelium leucoblepharis** (Trin.) Gould and Clark var. **glabrescens** (Griseb.) Gould et Clark

Panicum strigosum MUHL = **Dichanthelium leucoblepharis** var. **pubescens** (Vasey) Gould et Clark

Panicum joorii Vasey and *P. commutatum* Schult. = **Dichanthelium commutatum** (Schult.) Gould

Panicum sphaerocarpon Ell. = **Dichanthelium sphaerocarpon** (Ell.) Gould

Panicum erectifolium Nash = **Dichanthelium erectifolium** (Nash) Gould et Clark

Panicum scoparium Lam. = **Dichanthelium scoparium** (Lam.) Gould

Panicum aciculare Desv. ex Poir. and *P. angustifolium* Ell. and *P. arenicoloides* Ashe and *P. fusiforme* Hitchc. = **Dichanthelium aciculare** (Desv. et Poir.) Gould et Clark

Panicum dichotomum L. and *P. caerulescens* Hack. ex Hitchc. = **Dichanthelium dichotomum** (L.) Gould

Panicum tenue Muhl. and *P. albomarginatum* Nash and *P. trifolium* Nash = **Dichanthelium dichotomum** var. **tenue** (Muhl.) Gould et Clark

Panicum acuminatum Sw. and *P. chrysopsidifolium* Nash = **Dichanthelium acuminatum** (Sw.) Gould et Clark

Panicum auburne Ashe and *P. albemarlense* Ashe = **Dichanthelium acuminatum** var. **implicatum** (Scribn.) Gould et Clark

Panicum wrightianum Scribn. = **Dichanthelium acuminatum** var. **wrightianum** (Scribn.) Gould et Clark

Panicum longiligulatum Nash = **Dichanthelium acuminatum** var. **longiligulatum** (Nash) Gould et Clark

Paspalum ciliatifolium Michx. and *P. propinquum* Nash = **Paspalum setaceum** Michx. var. **ciliatifolium** (Michx.) Vasey

Paspalum secans Hitchc. et Chase = **Paspalum pleiostachyum** Doell. in Mart.

Andropogon L. s.l.

According to GOULD (1967, 1974) and other agrostologists the genus *Andropogon* had been also segregated into several genera, as *Botriochloa* Kuntze, *Dichanthium* Willemet, *Schizachyrium* Nees and *Andropogon* L. s. str. The following key serves for distinguishing the mentioned genera:

1 a Flowering culms much branched, each terminal branchlet bearing a single raceme above the uppermost leaf ..... *Schizachyrium*
  b Flowering culms much or little branched, each culm or branch terminating in an inflorescence of two to numerous racemose branches above the uppermost leaf **2**
2 a Pedicels at least those above, and upper rachis joints with a central groove or membranous area ..... *Botriochloa*
  b Pedicels and rachis joints flat or rounded, without a central groove or membranous area **3**
3 a Pedicelled spikelet reduced or absent, tapering to a narrow apex ..... *Andropogon*
  b Pedicelled spikelet about as large as the sessile one, rounded at the apex .. *Dichanthium*

According the above taxonomic segregation, for the Cuban species the following nomenclatural changes are due:

Andropogon nodosus (Willem.) Nash = **Dichanthium aristatum** (Poir.) C. E. Hubb.
Andropogon caricosus L. = **Dichanthium caricosum** (L.) Stapf
Andropogon annulatus Forssk. = **Dichanthium annulatum** (Forssk.) Stapf
Andropogon condilotrichus Hochst. = **Dichanthium condilotrichum** (Hochst.) Stapf
Andropogon pertusus (L.) Willd. = **Botriochloa pertusa** (L.) A. Camus
Andropogon saccharoides Sw. = **Botriochloa saccharoides** (Sw.) Rydb.
Andropogon gracilis (Spreng.) Nash = **Schizachyrium gracile** (Spreng.) Nash
Andropogon multinervosus (Nah) Hitchc. et Chase = **Schizachyrium multinervosum** Nash
Andropogon tener (Nees) Kunth = **Schizachyrium tener** Nees
Andropogon semiberbis (Nees) Kunth = **Schizachyrium semiberbis** Nees
Andropogon hirtiflorus (Nees) Kunth = **Schizachyrium domingense** (Spreng.) Nash
Andropogon brevifolius Sw. = **Schizachyrium brevifolium** (Sw.) Nees
Andropogon malacostachyus Presl = **Schizachyrium malacostachyum** (Presl) Nash
Andropogon cubensis Hack. = **Schizachyrium cubense** (Hack.) Nash
Andropogon reedii Hitchc. et Ekm. Man. Grass. West Ind. 1936: 390 = **Schizachyrium reedii** (Hitchc. et Ekm.) Borhidi et Catasus **comb. n.**
Andropogon parvifolius Hitchc. Man. Grass. West Ind. 1936: 391 = **Schizachyrium parvifolium** (Hitchc.) Borhidi et Catasus **comb. n.**

Cyperaceae

Scirpus validus Vahl = **Schoenoplectus validus** (Vahl) Palla
Scirpus olneyi A. Gray ex Engelm. = **Schoenoplectus americanus** (Pers.) Volkart ex Schinz et Keller
Scirpus micranthus Vahl = **Hemicarpha micrantha** (Vahl) Pax in Engl. et Prantl
Eleocharis geniculata sensu Clarke in Urb. = **E. elegans** (HBK.) Roem. et Schult.
Eleocharis caribaea (Rottb.) S. F. Blake = **E. geniculata** (L.) Roem et Schult.
Fimbristylis littoralis Gaud. in Alain: Suppl. Fl. Cuba 1969: 12 = **F. miliacea** (L.) Vahl
Fimbristylis spathacea Roth = **F. cymosa** R. Br. ssp. **spathacea** (Roth) Koy.
Fimbristylis castanea Michx. in Alain: Suppl. Fl. Cuba 1969: 12 = **F. spadicea** (L.) Vahl

Bulbostylis Kunth

Alain H. Liogier (Suppl. Fl. Cuba 1969: 11—12) suggested enclosure of the genus *Bulbostylis* Kunth into *Fimbristylis* Vahl according to a monographic revision of K. Svenson (N. Amer. Flora **18.** 1947—1957) and published a series of new combinations for the Cuban species. Actually, *Bulbostylis* Kunth is considered as a reestablished, valid genus (see T. Koyama in Howard: Fl. Less. Ant. **3:** 243). So the valid names of the Cuban species can be found in León, H. Flora de Cuba **1:** 206—207, 1946. Some additional data:
Fimbristylis bufonia (HBK.) Alain in Suppl. Fl. Cuba p. 11. = **Bulbostylis tenuifolia** McBr.
Fimbristylis carteri (Britt.) Alain l.c. p. 12. = **Bulbostylis ciliatifolia** Fernald
Fimbristylis savannarum Alain l.c. = **Bulbostylis arenaria** Lindm.

Cyperus L. s.l.

Cyperus had been divided into several genera based on structural differences in the flower and inflorescence, as soon as the second part of the past century. An up to date revision of the Antillean *Cyperaceae* was published by C. B. Clarke (Symbolae Antillanae **2.** 1901) — with additional remarks of I. Urban —, distinguishing the following genera: *Cyperus* L. s. str., *Kyllingia* Rottb., *Mariscus* Vahl, *Pycreus* Beauv., *Torulinium* Desv. and *Juncellus*

C. B. Clarke. In the Flora of Cuba *Cyperus* was elaborated by H. O'NEILL renovating the wide sense concept of this genus and uniting all the mentioned genera into *Cyperus* L. s.l. There is no doubt, the update concept of this group is — as it can be seen in most of the modern flora works — the separation of the original *Cyperus* L. into several genera. For the Cuban plants the following nomenclatural changes are suggested:

Cyperus flavescens L. = **Pycreus flavescens** (L.) Rchb.
Cyperus odoratus L. = **Pycreus odoratus** (L.) Urb.
Cyperus polystachyus Rottb. = **Pycreus polystachyos** (Rottb.) Beauv.
Cyperus paniculatus Rottb. = **Pycreus polystachyos** var. **laxiflora** Ridley
Cyperus lanceolatus Poir. = **Pycreus densus** (Humb. ap. Link) Urb.
Cyperus unioloides R. Br. = **Pycreus unioloides** (R. Br.) Urb.
Cyperus aristatus Rottb. = **Mariscus squarrosus** (L.) C. B. Clarke in Hook. f.
Cyperus confertus Sw. = **Mariscus confertus** (Sw.) C. B. Clarke in Urb.
Cyperus fuligineus Chapman = **Mariscus fuligineus** (Chapman) C. B. Clarke in Urb.
Cyperus ligularis L. = **Mariscus ligularis** (L.) Urb.
Cyperus planifolius L. C. Rich. = **Mariscus planifolius** (L. C. Rich.) Urb.
Cyperus brunneus Sw. (*C. planifolius* sensu LEÓN Fl. Cuba **1**: 195) = **Mariscus brunneus** (Sw.) C. B. Clarke in Urb.
Cyperus swartzii (Dietr.) Böckl. = **Mariscus gracilis** Vahl
Cyperus tenuis Sw. = **Mariscus tenuis** (Sw.) C. B. Clarke in Urb.
Cyperus hermaphroditus (Jacq.) Standl. = **Mariscus hermaphroditus** (Jacq.) Urb.
Cyperus nanus Willd. var. *subtenuis* Kük. = **Mariscus capillaris** (Sw.) Vahl
Cyperus subumbellatus Kük. = **Mariscus alternifolius** Vahl
Cyperus flavus (Vahl) Nees = **Mariscus cayennensis** (Lam.) Urb.
Cyperus globosus Aubl. = **Mariscus globosus** (Aubl.) Urb.
Cyperus brevifolius (Rottb.) Hassk. = **Kyllingia brevifolia** Rottb.
Cyperus sesquiflorus (Torr.) Mattf. et Kük. p. maj. p. = **Kyllingia odorata** Vahl
Cyperus sesquiflorus sensu LEÓN in Fl. Cuba **1:** 190 p. min. p. = **Kyllingia monocephala** Rottb.
Cyperus densecespitosus Mattf. et Kük. = **Kyllingia pumila** Michx.
Cyperus neo-urbanii Kük. = **Kyllingia urbanii** Kük.
Cyperus flexuosus Vahl = **Torulinium flexuosum** (Vahl) Koy.
Cyperus odoratus L. = **Torulinium odoratum** (L.) Hooper
Cyperus filiformis Sw. = **Torulinium filiforme** (Sw.) C. B. Clarke in Urb.
Rhynchospora setacea (Berg) Boeckl. = **R. tenerrima** Nees ex Spreng.
Rhynchospora cyperoides (Sw.) Mart. = **R. holoschoenoides** (L. C. Rich.) Herter
Scleria melaleuca Rchb. ex Schlecht et Cham. = **S. pterota** Presl

Arecaceae

Acrocomia aculeata auct. cub. non (Jacq.) Lodd. = **Acrocomia spinosa** (Mill.) H. E. Moore

Araceae

Xanthosoma cubense (A. Rich.) Schott = **Asterostigma cubense** (A. Rich.) K. Krause ex Bogner

Amaryllidaceae

Crinum oliganthum Urb. is not identical with *C. erubescens* Ait., as it is stated by Alain H. LIOGIER Suppl. Fl. Cuba 1969: 40.
Crinum zeylanicum L. = **C. latifolium** L. var. **zeylanicum** (L.) Hook. f.

Pancratium caribaeum L. = **Hymenocallis caribaea** (L. em. Gawl.) Herb.
Pancratium praticolum (Britt. et Wils.) Alain Suppl. Fl. Cuba 1969: 40 = **Hymenocallis praticola** Britt. et Wils.
Pancratium arenicolum (Northrop) Alain l.c. = **Hymenocallis arenicola** Northrop
Pancratium ovatum Mill. = **Hymenocallis ovata** (Mill.) Roem.

Zingiberaceae

Renealmia aromatica (Aubl.) Griseb. = **R. occidentalis** (Sw.) Sweet var. **occidentalis**
Costus cylindricus Jacq. = **Costus spicatus** (Jacq.) Sw.

Commelinaceae

Tradescantia geniculata auct. cub. non Jacq. = **Gibasis pauciflora** (Urb. et Ekm.) D. R. Hunt, according to the Kew Bull. **33:** 146, 1978 (Basionymon: *Tradescantia pauciflora* Urb. et Ekm. Ark. f. Bot. Stockh. **23.** no. 11: 7, 1931). *Gibasis geniculata* (Jacq.) Rohweder, reported by Alain H. Liogier from Cuba in the Suppl. Fl. Cuba 1969: 38, probably does not occur in Cuba.

Orchidaceae

Lepanthes in Cuba

A valuable critical revision of the Cuban species of this genus was published by H. Hespenheide (Brittonia 25: 257—283, 1973) describing six new species to science, all endemic to Cuba, contributing a new combination and some important nomenclatural and taxonomic corrections as follows:

Pleurothallis blepharophylla Griseb. = **Lepanthes blepharophylla** (Griseb.) Hespenheide
Lepanthes acunae Hespenheide **sp. n.** Holotype: Morton et Acuna 3675; Sierra Maestra between Pico Turquino and La Bayamesa, 1350 m. US; isotype: HAC
Lepanthes longicruris Schltr. = **Lepanthes trichodactyla** Lindl.
Lepanthes ovalis auct. cub. non (Sw.) Fawc et Rendle = **Lepanthes melanocaulon** Schltr.
Lepanthes dressleri Hespenheide **sp. n.** Holotype: Sierra de Escambray about Pico Sombrero, NE of El Naranjo; Dressler 1341 US. Area: Sierra del Rosario (PR), Sierra de Escambray (LV) Monte Verde (Or.), endemic.
Lepanthes pristidis auct. cub. non Rchb. f. = **Lepanthes cubensis** Hespenheide **sp. n.** Holotype: Wright 1512 p.p. Or.: Monte Verde. Area: Sierra de Nipe, Monte Verde, endemic.
Lepanthes tridentata auct. cub. non Sw. = **Lepanthes grisebachiana** Hespenheide **sp. n.** Holotype: Wright 1510 Or.: Monte Verde; Area: Sierras de Nipe, Cristeal y Moa, Monte Verde, endemic.
Lepanthes obliquipetala Hespenheide **sp. n.** Holotype: Dressler 1333 (US), Sierra de Escambray 3 km NE of El Naranjo; endemic.
Lepanthes ovata Ames et Schweinf. = **Lepanthes ekmanii** Schltr.
Lepanthes occidentalis Hespenheide **sp. n.** Holotype: Las Villas: 12 km S of Manicaragua, steep rocky wooded slopes; Dressler 1294 (US), endemic.
Lepanthes mandibularis Rchb. f. = **Lepanthes chrysostigma** Lindl.
Lepanthes lindmaniana Schltr. = **Lepanthes fulva** Lindl.
Lepanthes brevipetala Fawc. et Rendle = **Lepanthopsis brevipetala**
Lepanthes leonii Schweinf. ex León = **Lepanthopsis microlepanthes** (Griseb.) Ames
Lepanthes loddigesiana Rchb. f., *L. ovalis* and *L. tridentata* (Sw.) Sw. are endemic to Jamaica, *L. pristidis* Rchb. f. is an endemic Mexican species and do not occur in Cuba.

Epidendrum cubincola Borhidi Acta Bot. Acad. Sci. Hung. 22: 295. 1976. = **Dinema cubincola** (Borhidi) Dietrich.

Caesalpiniaceae

Bauhinia cumanensis HBK. = **Bauhinia glabra** Jacq. according to WUNDERLIN Ann. Mo. Bot. Gard. **63:** 352, 1976.

Guttiferae

Revising the African *Garcinia* and *Rheedia* species, ROBSON found (Bol. Soc. Broteriana **32:** 170—173, 1958) that there was not possible to make a good distinction between *Garcinia* sect. *Tetracentrum* and genus *Rheedia* based on the structure of the flower. Both taxa differs from *Garcinia* subgenus *Rheediopsis*, in having free stamens, but this feature is considered to be insufficient for creating a natural taxonomic unit. ROBSON concluded that *Garcinia* and *Rheedia* could not be maintained as separate genera (l.c. p. 172). According to this suggestion ADAMS (Phytologia **20:** 312, 1970, and Flora of Jamaica 1972) included the Jamaican species of *Rheedia* into *Garcinia* L. Accepting the later concept, we have to use the following combinations: for the Cuban species of *Rheedia*:

Rheedia aristata Griseb. Cat. Plant. Cub. 1866: 38. Lipsiae, typus: CH. WRIGHT 2121. = **Garcinia aristata** (Griseb.) Borhidi **comb. n.**

Rheedia bakeriana Urb. Symb. Ant. **5:** 435, 1908; typus: BAKER 4953. = **Garcinia bakeriana** (Urb.) Borhidi **comb. n.**

Rheedia brevipes Britt. Mem. Torr. Bot. Club **16:** 83, 1920. Typus: BRITTON et COWELL 10262. non *Garcinia brevipes* Pierre Fl. Forest. Cochinch. fasc. 5: 3, 1883, Borneo = **Garcinia clarensis** Borhidi **nomen novum.**

Rheedia cincta Urb. Symb. Ant. **9:** 404, 1925. Typus: EKMAN 9341 = **Garcinia cincta** (Urb.) Borhidi **comb. n.**

Rheedia cubensis Borhidi Acta Bot. Acad. Sci. Hung. **22:** 313, 1976. Typus: LEÓN 9320. = **Garcinia cubensis** (Borhidi) Borhidi **comb. n.**

Rheedia elliptica Wr. in Sauv. Anal. Acad. Habana **8:** 152, 1868. Typus: CH, WRIGHT 147; non *Garcinia elliptica* Choisy in De Candolle Prodr. **1:** 561. 1824 Malaya; = **Garcinia pungens** Borhidi **nomen novum**

Rheedia fruticosa Wr. in Griseb. Cat. Plant. Cub. 1866: 38. Lipsiae, Typus: CH. WRIGHT 2120; non *Garcinia fruticosa* Lauterb. in Engl. Bot. Jahrb. **58:** 31, 1922. New Guinea; = **Garcinia serpentini** Borhidi **nomen novum**

Rheedia moaensis Bisse Ciencias Univ. Habana ser. 10. Botánica **2:** 16, 1975. Typus: HAJB 3151. = **Garcinia moaensis** (Bisse) Borhidi **comb. n.**

Rheedia ophiticola Borhidi Acta Bot. Acad. Sci. Hung. **22:** 312, 1976. Typus: CLEMENTE 4325. = **Garcinia ophiticola** (Borhidi) Borhidi **comb. n.**

Rheedia polyneura Urb. Feddes Repert. **18:**18, 1922. Typus: EKMAN 3557. = **Garcinia polyneura** (Urb.) Borhidi **comb. n.**

Rheedia revoluta Urb. Symb. Ant. **9:** 405, 1925. Typus: EKMAN = **Garcinia revoluta** (Urb.) Borhidi **comb. n.**

Rheedia ruscifolia Griseb. Mem. Amer. Acad. **8:** 167, 1860. Typus: CH. WRIGHT 53. = **Garcinia ruscifolia** (Griseb.) Borhidi **comb. n.**

Rheedia ruscifolia var. *linearis* Borhidi Acta Bot. Acad. Sci. Hung. **22:** 313, 1976. = **Garcinia ruscifolia** (Griseb.) Borhidi var. **linearis** (Borhidi) Borhidi **comb. n.**

Combretaceae

Terminalia canescens Borhidi et Muñiz Acta Agron. Acad. Sci. Hung. **27:** 436, 1978. non *Terminalia canescens* Radlk. 1928. nec *Alectryon canescens* DC.1836 = **Terminalia bipleura** Borhidi et Muñiz **nomen novum**

Oleaceae

Linociera Schreb.

According to T. W. STEARN (Ann. Mo. Bot. Gard. **63:** 355—357, 1976) the genus *Chionanthus* L. Sp. Pl. **1:** 8, 1753. based on the type: *C. virginicus* L. does not differ essentially from the genus *Linociera* Schreb. Gen. Pl. **2:** 784, 1791, based on the type: *Thouinia ligustrina* Sw. For this reason STEARN suggested a series of new combinations for the Cuban species of *Linociera* and I propose two others as follows:

Linociera acunae Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **25:** 50, 1979. = **Chionanthus acunae** (Borhidi et Muñiz) Borhidi **comb. n.**

Linociera axilliflora Griseb. = **Chionanthus axilliflorus** (Griseb.) Stearn

Linociera bakeri Urb. = **Chionanthus bakeri** (Urb.) Stearn

Linociera bumelioides Griseb. = **Chionanthus bumelioides** (Griseb.) Stearn

Linociera bumelioides ssp. *obovalis* Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **25:** 50, 1979. = **Chionanthus bumelioides** (Griseb.) Stearn ssp. **obovalis** (Borhidi et Muñiz) Borhidi **comb. n.**

Linociera cubensis (P. Wils.) Urb. = **Chionanthus cubensis** (P. Wils.) Stearn

Linociera domingensis (Lam.) Urb. = **Chionanthus domingensis** Lam.

Linociera ligustrina Sw. = **Chionanthus ligustrinus** (Sw.) Stearn

Linociera moncadae Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **25:** 50, 1979. = **Chionanthus moncadae** (Borhidi et Muñiz) Borhidi **comb. n.**

Haenianthus grandifolius Urb. is a good species and not identical with *H. salicifolius* Griseb. as it was treated by Alain H. LIOGIER in the Flora de Cuba IV: 148. ALAIN obviously had not acces to see the type specimen of *H. grandifolius* Urb. and could not recognize it based on the description. The

Fig. 61 of the Flora de Cuba vol. IV, under the name of *Haenianthus variifolius* Urb. is not else, than an authentic specimen of *H. grandifolius* Urb. collected next to the Rio Toa by ALAIN in 1953.

Gentianaceae

Leiphaimos Cham. et Schlecht.

According to L. O. WILLIAMS (1968) and A. ROBYNS (1969) the American species of *Leiphaimos* do not differ essentially from the earlier described *Voyria*. Therefore for the Cuban species of *Leiphaimos* the following combinations are suggested as valid:

Leiphaimos aphylla (Jacq.) Gilg = **Voyria aphylla** (Jacq.) Pers.

Leiphaimos brachyloba (Griseb.) Urb. = **Voyria brachyloba** Griseb.

Leiphaimos disadenantha (Griseb.) Alain = **Voyria disadenantha** Griseb.

Leiphaimos parasitica Cham. et Schlecht. = **Voyria parasitica** (Cham. et Schlecht.) Griseb.

Apocynaceae

Plumeria L.

On the highly problematic Cuban species of the genus *Plumeria* L. a very careful revision has been recently published by LIPPOLD (Feddes Repert. **90:** 193—215, 1979). The author in his excellent study reestablishes the existence of 12 valid species of *Plumeria* in the flora of Cuba, all endemics. Based on the results of the mentioned paper the data of LEÓN and ALAIN: Flora de Cuba IV. 173—176 are to be changed as follows:

Plumeria stenophylla Urb. = **Plumeria filifolia** Griseb.

P. tuberculata sensu León and Alain non Lodd. = **P. sericifolia** Wr. in Griseb. Endemic in PR., Hab., and Mat.

P. clusioides Griseb. non León et Alain is a valid, very restricted endemic species of the Monte Libano group and the South Coastal Range of Baracoa.

P. clusioides León et Alain non Griseb. p. maj. p. = **P. cubensis** Urb. Endemic to the serpentine zones of Middle Cuba from the Prov. Habana to the serpentine area of Holguin: Hab., Mat., LV., Cam., and Or.

P. clusioides León et Alain non Griseb. p. min. p. = **P. nipensis** Britt. Endemic to the serpentine ranges of the Sierra de Nipe and Cristal.

P. clusioides León et Alain p. min. p. non Griseb. = **P. ekmanii** Urb. Endemic to the Moa-Toa-Baracoa ranges, Monte Libano group, Sierra de Imias, Yunque de Baracoa. Occurs on both limestone and serpentine rocks.

P. obtusa León et Alain non L. p. maj. p. = **P. emarginata** Griseb. Endemic to the limestone cliffs and coastal zone of West-Cuba and Isle of Pines in the Provinces PR., Hab., Mat., LV.

P. obtusa León et Alain non L. p. min. p. = **P. venosa** Britton as for the plants of the coastal zone of the Province Oriente.

Lamiaceae

Satureja L.

Examinating the generic features of *Satureja* L. and *Micromeria* Benth. on the Cuban species of *Satureja*, there is no doubt, that they must belong to *Micromeria* by having 13—15 nerved tubulous calyx. For this reason the following nomenclatural changes are suggested:

Satureja viminea L. = **Micromeria viminea** (L.) Urb.
Satureja bucheri (P. Wils.) Urb. = **Micromeria bucheri** P. Wils.
Satureja suborbicularis Alain Contrib. Ocas. Mus. Hist. Nat. La Salle, Habana **15:** 13, 1956. = **Micromeria suborbicularis** (Alain) Borhidi **comb. n.**[1]
Satureja brownei (Sw.) Briq. = **Micromeria brownei** (Sw.) Benth.

Scrophulariaceae

Anisantherina hispidula (Mart.) Pennell = **Agalinis hispidula** (Mart.) D'Arcy, according to D'Arcy: Ann. Mo. Bot. Gard. **65:** 769—770, 1978.

Fig. 1. Holotype specimen of *Isidorea rheedioides* Borhidi (Alain 7097, HAC)

Acanthaceae

Justicia verticillaris (Nees) Urb. = **J. martinsoniana** Howard J. Arn. Arb. **49:** 400, 1968.

Rubiaceae

Portlandia P. Browne s.l.

A very notable study has been recently published on the genus *Portlandia* and other related genera by A. Aiello (J. Arn. Arb. **60:** 38—126, 1979). The author differs 12 genera, 4 of them describes as new ones based on a thorough,

Fig. 2. Isidorea ophiticola (Borhidi) Borhidi et Moncada, holotype specimen (UO 1037, HAC)

Fig. 3. Holotype specimen of *Isidorea acunae* (Borhidi) Borhidi et Moncada (ALAIN 7381, HAC)

multifacetic investigation, but mostly on ovary structure and placentation. According to her concept, *Portlandia* P. Brown is an endemic genus to Jamaica and does not occur in Cuba. Cuban species treated formerly as *Portlandias* belong to four different genera: *Cubanola* Aiello, *Thogsennia* Aiello, *Isidorea* A. Rich. and *Ceuthocarpus* Aiello. Based on the excellent treatment and results of the mentioned study the following nomenclatural changes are suggested:

Portlandia daphnoides R. Graham = **Cubanola daphnoides** (R. Graham) Aiello

Portlandia lindeniana (A. Rich.) Britt. = **Thogsennia lindeniana** (A. Rich.) Aiello

Portlandia acunae Borhidi Abstracta Bot. Univ. Budapest **5:** 35, 1977 = **Isidorea acunae** (Borhidi) Borhidi et Moncada **comb. n.**

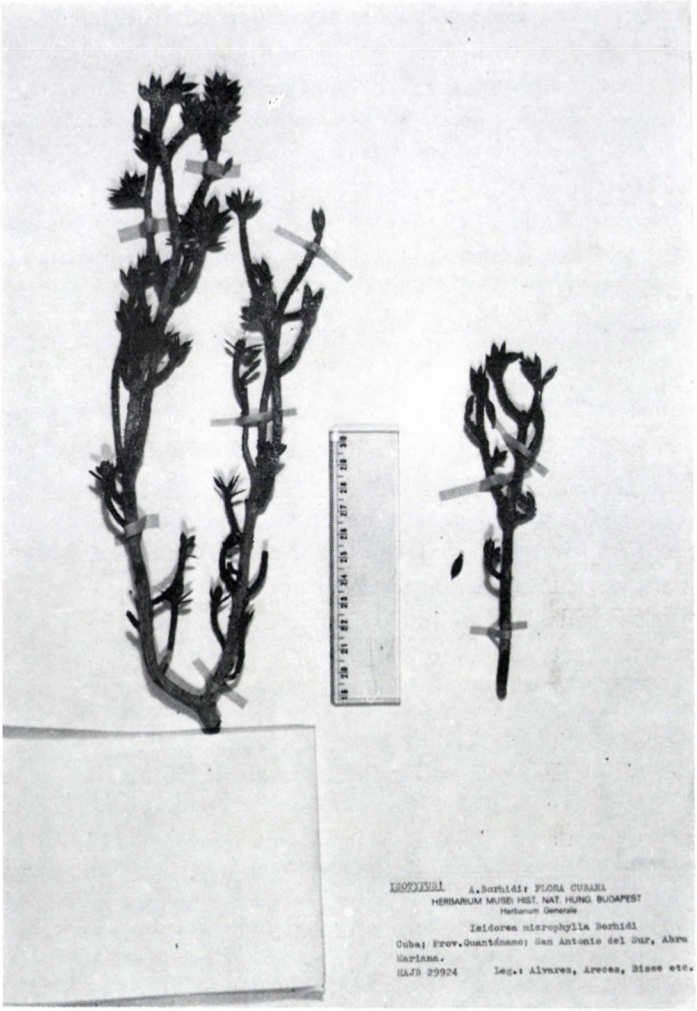

Fig. 4. Isotype specimen of *Isidorea microphylla* Borhidi (29924 HAJB in BP)

Portlandia brachycarpa Urb. = **Isidorea brachycarpa** (Urb.) Aiello
Portlandia oblanceolata Urb. = **Isidorea oblanceolata** (Urb.) Aiello
Portlandia ophiticola Borhidi Abstracta Bot. Univ. Budapest **5:** 34, 1977. = **Isidorea ophiticola** (Borhidi) Borhidi et Moncada **comb. n.**
Portlandia polyneura Urb. = **Isidorea polyneura** (Urb.) Aiello
Schmidtottia involucrata (Wernh.) Alain = **Ceuthocarpus involucratus** (Wernh.) Aiello

A comparative pollen morphological study made by M. Moncada (unpubl.) on Jamaican and Cuban *Portlandia* species proved that *Portlandia acunae* Borhidi, *P. brachycarpa* Urb., *P. oblanceolata* Urb., *P. ophiticola* Bor-

hidi and *P. polyneura* Urb. have an exine structure different from that of Jamaican *Portlandia* species. The mentioned Cuban species proved to have the same form and exine-pattern as the pollen grains of *Isidorea* species have. So the results obtained by M. MONCADA confirmed the decision of A. AIELLO, that mentioned Cuban species do not belong to the genus *Portlandia* and they are really *Isidorea* species.

Ceuthocarpus Aiello is a monotypic serpentinicolous new genus, endemic to Eastern Cuba. **Thogsennia** Aiello is also a monotypic new genus, living in Eastern Cuba and Hispaniola. **Cubanola** Aiello includes two species, one is endemic to Cuba other one to Hispaniola.

Some new taxa of Isidorea and Schmidtottia

Simultaneously with the study of AIELLO a revision of the Cuban *Isidorea* and *Schmidtottia* species was carried out by A. BORHIDI for the purposes of the New Flora of Cuba. The first results of this study were published by BORHIDI, MUÑIZ and CAPOTE (1977) with descriptions of 5 species new to science. Further results are as follows:

Isidorea microphylla Borhidi **sp. n.**

Frutex 30—80 cm altus. Rami veteriores suberoso-lineolati, albi, superne cicatricibus densissime confertis valde muricati, internodiis 0.5—1 mm longis. Stipulae interpetiolares triangulares vel ovatae, margine incrassatae, 1—3 mm longae, apice sensim subulato aristatae, arista 1—3 mm longa suffultae. Folia 0,5—1,5 mm longe petiolata, lanceolata vel oblongo-elliptica, sub medio latissima basi breviter cuneata et petiolum marginantia, antice sensim angustata, apice ipso acuta et 0,5—1,5 mm longe spinoso-mucronata, 0,6—1,2 cm longa et 3—4,5 mm lata, nervo medio supra late impresso et obsoleto, subtus crasse prominenti, lateralibus utrinque nullis; lamina margine incrassata, haud vel non revoluta, supra lucida et sparse albo-punctata, subtus pallide viridis, utrinque glabra, rigidissime coriacea. Flos terminalis vel in axillis superioribus sessilis. Calycis tubus angulatus, glaber, 2 mm longus, lobi 5, oblongo-lanceolati, 2—3 mm longi, enervati. Corolla non visa. Capsula globosa, leviter 10-angulata, 4—4,5 mm longa et lata, bilocularis, loculicide bivalva, lobis calycinis obsolete univervibus coronata. Semina elliptica, lateraliter compressa, basim versus lateraliter arilosa.

Holotypus: 29924 HAJB; Cuba; Prov. Guantánamo, San Antonio del Sur, Abra Mariana. Leg.: ALVAREZ, ARECES, BISSE et al. Isotypi: JE, HAC, BP.

Obs.: *Isidoreae ellipticae* Alain affinis, quae a specie nostra stipulis longius aristatis, foliis ellipticis, 1—2 cm longis, margine valde revolutis, calycis lobis triangularibus 3-nervibus coriaceisque pungentibus, capsula obovata, in axillis 2—4 conferta, 6—7 mm longa, breviter pedicellata certe specifice differt.

Fig. 5. Isotype specimen of *Isidorea elliptica* Alain (ALAIN 4198 in BP)

Schmidtottia monticola Borhidi **sp. n.**

Frutex ramosus usque ad 2 m altus, valde resinosus. Rami hornotini 4-angulosi, nigrescentes, puberuli et resina induti, veteriores cinerei longitudinaliter striati, glabri. Stipulae annulares, 1—2 mm longae truncatae, margine strigillosae vel fimbriatae, valde resinosae.

Folia sessilia, 1,5—4 cm longa et lata, orbicularia vel orbiculari-ovata, apice rotundata basi cordata vel truncata, nervo medio supra leviter impresso, subtus prominulo, lateralibus utroque latere 4—5, utrinque obsoletis vel supra nullis et subtus levissime prominulis, lamina supra lucida, glabra, in sicco nigricans et leviter plicatula, subtus pallidior et pilis longis sparse puberula, margine tenuiter revoluta coriacea.

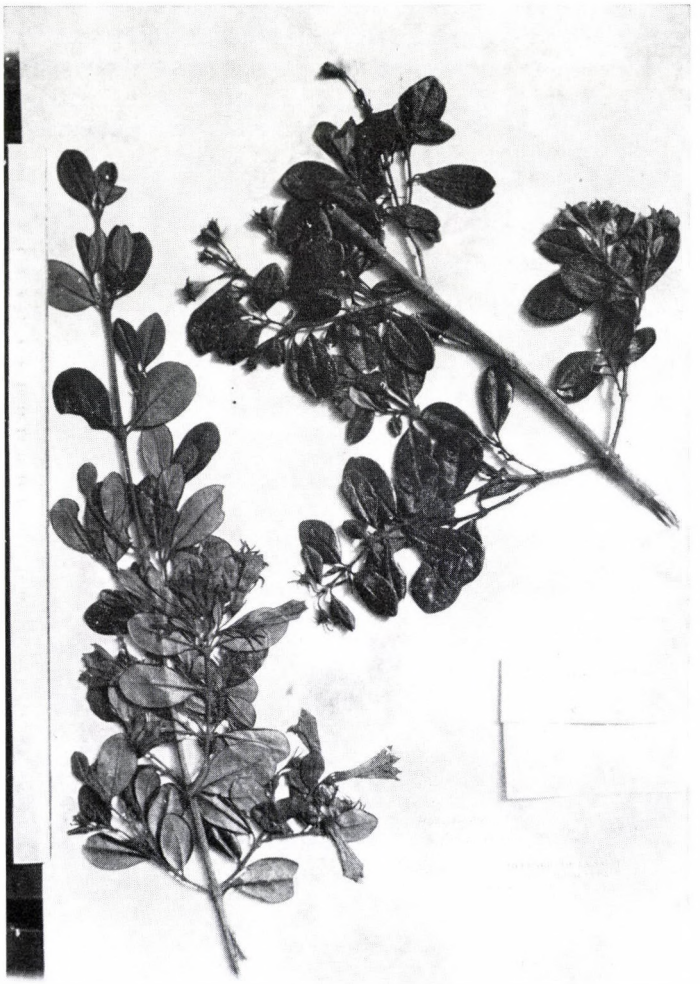

Fig. 6. Schmidtottia corymbosa Borhidi, holotype specimen (CLEMENTE 5543 HAC)

Inflorescentia terminalis, sessilis, 3-pluriflora, valde resinosa. Stipulae involucrales con natae, foliis 2, orbicularibus involucralibus suffulta.

Calyx 4 mm longus et 2 mm latus, breviter pilosus resinosus, lobi 4, 4—5 mm longi, lineares, subulati glabri. Corollae tubus 2—2,5 cm longus, 3 mm latus, lobi triangulares 2—3 mm longi obtusi. Tubus 5-angulatus apicem versus cum lobis extus puberulus. Stamina 5, filamenta filiformia 1,2—1,5 cm longa, basim versus puberula, basi dilatata tubum adnata et inter sese connata, antherae lineari-lanceolatae 5—7 mm longae in tubo insertae. Stylus filiformis, 2,2—2,4 mm longus brevissime bilobatus.

Fructus capsula obovata, 7—8 mm longa, oscure 8-costulata, glabra, apice lobis calycinis triangular-subulatis 3—5 mm longis cornata. Discus 4-lobatus.

Fig. 7. Holotype specimen of *Schmidtottia stricta* Borhidi (27797 HAC)

Holotypus: Cuba, Prov. Oriente, Sierra de Moa, 800 m.s.m. charrascos. Leg.: ALAIN 26. jul. 1953. 3447. HAC.

Obs.: *Schmidtottiae sessilifoliae* (Britt.) Urb. affinis, quae a specie nostra foliis supra scabrosis, calyce 5-lobato, lobis hirsutis, corolla usque ad 1,5 cm longa, capsulis 5—6 mm longis clare differt.

Schmidtottia cucullata Borhidi et Bisse **sp. n.**

Rami hornotini 4-anguli in sicco elevatim plicato-striati, minute papilloso pilosi, internodiis 1,5—3,5 cm longis. Stipularum vagina antice truncata cca 1 mm longa. Folia opposita, 3—7 mm longe petiolata elliptica vel obovata basi attenuata vel obtusa, breviter in petiolum

protracta, antice rotundata, 3—5,5 cm longa et 1,5—3,5 cm lata, nervo medio supra inferne parum sulcata, supra medium leviter prominenti ante apicem obsoleto, subtus prominente et apicem versus evanescenti lateralibus utroque latere 3—5 supra inconspicuis, subtus obsoletis vel leviter prominulis, margine tenuiter recurva, coriacea utrinque valde discolora, glabra, supra nitidula in sicco nigrescentia, subtus flavida nitidula.

Inflorescentiae terminales, 1—3-florae, bracteae euphyllae orbiculares vel late obovatae rariter ellipticae, utrinque rotundatae, 7—15 mm longae, nervis lateralibus utrinque nullus, pedicelli 2—10 cm longi, puberuli. Calycis lobi 5, late lanceolati superne conduplicati, apice dorsaliter manifeste, rotundato-dilatati, cucullati, 7—8 mm longi, tubo 5 mm longo puberulo longiores pubescentes. Corolla non visa. Capsula obovato-turbinata, manifeste costata 10—12 mm longa superne 8—9 mm crassa, septicide dehiscens. Semina triangulari-orbiculata, puberula, basi acuta, minute reticulata, plana, 3 mm longa.

Holotypus: 17618 HAJB; Cuba; Prov. Holguin (Oriente) Moa; Sierra de Moa, Cayo Coco, charrascales en 200—300 m.s.n.m. Leg.: Bisse et Lippold, 13. 8. 1970. Isotypus: JE.

Obs.: *Schmidtottiae marmoratae* Urb. affinis sed lobis calycinis superne rotundato-dilatatis, lateraliter compressis, et conduplicatis, apice cucullatis inter omnes alias huius generis insignis.

Schmidtottia shaferi (Standl.) Urb.

— — ssp. *shaferi*: lobis calycinis triangularibus vel oblongo-triangularibus, 1—3 mm longis, rectis, capsulis 10—12 mm longis, manifeste 10-costatis.

— — ssp. **neglecta** Borhidi **ssp. nova**

a typo differt: lobis calycinis lanceolatis, 3—5 mm longis recurvatis, capsulis 7—10 mm longis, 4-angulosis et leviter 8—10 costulatis

Holotypus: León 23227 HAC; Cuba, Prov. Holguin (Oriente) in pinetis prope Mina Franklyn, Moa; in alt. 400 m.s.m. Leg.: León et Clemente 20. jul. 1947. HAC! Isotypus: BP!

Specimina examinata: Sierra de Moa, Pinares de Cayo Fortuna, in alt. aprox. 800 m.s.m. Leg.: Alain H. Liogier 3298 HAC. — Cayo Fortuna, Toa, J. Bisse HAJB; — Cayo Fortuna, Cuchillas de Toa, Riito a Piloto Arriba, Leg.: Bisse et Berazain HAJB 22094; — Cayo Coco, Moa, alt. 200—300 m.s.m. Leg.: Bisse et Lippold HAJB 17661 — Mina Iberia, monte nublado 600—700 m.s.m. Bisse et Lippold 7130, 6310, HAJB; — La Melba charrascal del aserrio, 400—500 m.s.m. Bisse et Lippold 11405, 7195 HAJB, Bisse et Köhler 26849, Lippold 12440 HAJB.

Schmidtottia elliptica (Britt.) Urb.

— — ssp. *elliptica*: foliis late ellipticis, latitudine 1,3—1,6-plo longioribus, euphyllis suborbicularibus vel orbicularibus, capsula late obovata vel obpyramidale, 7—9 mm longa.

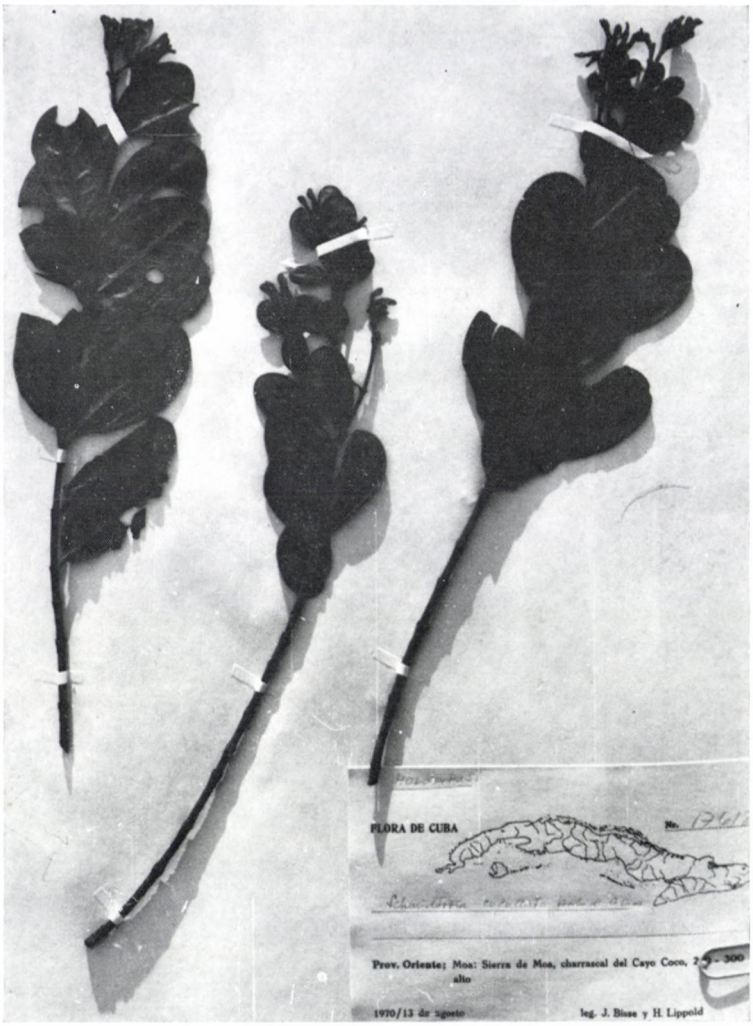

Fig. 8. Holotype specimen of *Schmidtottia cucullata* Borhidi et Bisse (17618 HAJB)

— — ssp. **oblongata** Borhidi **ssp. nova**

a typo differt: foliis oblongo-ellipticis, latitudine duplo longioribus, usque ad 7 cm longis et 3,5 cm latis, inflorescentiis euphyllis obovatis, capsula oblongo-obovata 10—12 mm longa

Holotypus: CLEMENTE 6829 HAC; Cuba, Prov. Holguin (Oriente), Moa; Cayoguán, camino hacia la Mina Delta. Leg.: CLEMENTE et ALAIN 15—16. jul. 1949. Isotypus: ALAIN 929 HAC!

Specimina examinata: Moa: carrascales al este de Yamanigüey, Leg.: BISSE et LIPPOLD 12090 HAJB; — Moa: Yamanigüey en las orillas del rio al oeste del pueblo. Leg.: BISSE et KÖHLER 6721 HAJB, BISSE et LIPPOLD 11991 HAJB.

Compositae

Borrichia cubana Britt. et Blake = **Borrichia × cubana** (Britt. et Blake). Semple according to a study of SEMPLE Ann. Mo. Bot. Gard. **65:** 681—693, 1978.

According to the results of the study published by R. M. KING and H. ROBINSON in Phytologia **19:** (1970) the following nomenclatural changes are suggested:

Eupatorium paucibractearum Alain = **Ageratina paucibracteata** (Alin) R. M. King et H. Robins.
Eupatorium havanense HBK. = **Ageratina havanensis** (HBK.) R. M. King et H. Robins.
Eupatorium × mortonianum Alain = **Ageratina mortoniana** (Alain) R. M. King et H. Robins.
Eupatorium corylifolium Griseb. = **Ageratina corylifolia** (Griseb.) R. M. King et H. Robins.
Eupatorium riparium Regel = **Ageratina riparia** (Regel) R. M. King et H. Robins.

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I am grateful to Harvard Professor Dr. R. A. HOWARD for the helpful criticism of my earlier papers and for his generously offered advises and suggestions orienting me in some taxonomic and nomenclatural problems.

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ACUNAEANTHUS, A NEW GENUS OF RUBIACEAE

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Upon the base of detailed morphological and palynological studies, the authors found, that two Cuban species of the genus *Neomazaea* (*Rubiaceae*) *Rondeletieae* tribe, *N. phialanthoides* (Griseb.) Urb. and *N. tinifolia* (Griseb.) Urb. are different at generic level. *Neomazaea tinifolia* represents a new genus of *Rubiaceae*, and the authors wish to dedicate it to the memory of the great Cuban botanist, J. ACUÑA GALE, by the name of *Acunaeanthus*.

Introduction

Three species of the genus *Rondeletia* had been described by GRISEBACH (Catalogus Plantarum Cubensium 1866: 129) with note of interrogation as for their generic state: *Rondeletia ? phialanthoides*, *Rondeletia ? tinifolia* and *Rondeletia ? verbenacea*. During the last hundred years it turned out, that all the three would belong to different new genera.

At first *Ceratopyxis*, the monotypic endemic genus of the West Cuban haystack mountains was described by HOOKER f. (ex HOOKER 1883) based on the species *Rondeletia ? verbenacea* Griseb. Some years later KRUG and URBAN separated the genus *Mazaea* (Bot. Jahrb. 1892) based up on the species *Rondeletia ? phialanthoides* Griseb. But *Mazaea* proved to be a homonymon, and it has been denominated repeatedly by the same authors, creating the new generic name *Neomazaea* Krug et Urban. *Neomazaea* was considered as a West-Cuban monotypic endemic genus of the serpentine areas for many years, till 1927, when EKMAN and URBAN described a second species of this genus collected by EKMAN in Haiti describing it as *Neomazaea pungens*.

Rondeletia ? tinifolia Griseb. was considered by STANDLEY as a typical species of the monotypic section *Tinifoliae* Standl. of the genus *Rondeletia* (North Amer. Flora **26.** 1918). It differs from all the other species of *Rondeletia* in having 4-angled, elongated ovary and fruit. This systematic state of the mentioned species, however, did not prove to be satisfactory for STANDLEY himself either, who some years later could not recognize the same species, as a *Rondeletia*, and based on fruit specimen described it as a new species by the name of *Exostema leonis* Standl. (Publ. Field Mus. Hist. Nat. Chicago Bot. Ser. **8:** 338, 1931), which obviously was a synonym.

Other combination of that species was suggested by URBAN (Ark. för Bot. 21 A. No. 5. 1927:70) transferring it to the genus *Neomazaea*. By this nomenclatural change the originally described generic features of the *Neomazaea* have been reduced to the elongated capsule of septicidal dehiscence.

Discussion

Rondeletia ? tinifolia Griseb. is undoubtedly a very interesting plant, its morphology units features of different genera. Its corolla is identical with the one of *Rondeletia*, by the form and structure of its calyx and the persistent resiniferous lobes it looks like an *Acrosynanthus*. Its capsule resembles very much the fruit of the *Exostema ellipticum* Griseb., the winged seeds are like those of the plants belonging to the tribe *Condamineae*. The morphological

Table 1

		Neomazaea	*Acunaeanthus*
leaf		coriaceous	chartaceous
	size	1—2.5×0.3—0.8 cm	4—10×1.8—5 cm
	lateral nerves	inconspicuous	reticulate
	margine	revolute	plate
	indument	glabrous	puberulent
stipules	triangular	1—1.5 mm	3—4 mm
petiole		1—2.5 mm	6—18 mm
inflorescence	position	axillar	terminal and axillar
	type	cymose	cymose
	number of flowers	1—3	3—9
flower characters			
	number of floral parts	4	4
calyx	tube	contracted above	amplified
	in cross section	4-angled	8-coasted
sepals		pubescent	glabrous, grandular
		not resinous	resinuous
		smooth	plicate
corolla	shape	tubular	tubular
	length	5 mm	18—35 mm
	colour	orange to purple	white to rose
	faucial ring	present	absent
	throat	glabrous	villous
	lobes	fleshy, incrassate	concavious
	aestivation	imbricate	imbricate
pollen	shape	spheroidal-prolate	oblate sphaeroidal
	type	4—5 colporoidate	3-colporate
	length×width	15×16.5 μm	22×24.5 μm
	sexine	reticulate	granulate
ovary	disc	thin, pubescent	thick, glabrous
	ovules/locules	2—6	15—30
fruit	shape	oblong	oblong
	dehiscence	septicidal	septicidal
	calyx lobes	deciduous	persistent
	placenta	small, thin	thick
seed	shape	lanceo-lineal	winged
	funiculus	persistent	absent
	arrangement	acropetally appressed	basipetally imbricate

differences existing between *Neomazaea phialanthoides* (Griseb.) Krug. et Urb. and *N. tinifolia* (Griseb.) Urb. can be seen at the Table 1.

Endemic genera of the Antillean flora are mostly monotypic ones. In Cuba as many as 70 endemic phanerogamic genera can be found (BORHIDI and MUÑIZ 1980) and no less than 52 of them are monotypic. As for the family *Rubiaceae*, according to WILLIS (1973), about 37% of the genera are monotypic. In Cuba *Rubiaceae* are represented by 77 genera, 14 of them (18%) are monotypic, 12 are endemic and 9 (75%) of them are monotypic. According to AIELLO (1979) this fact may indicate that rapid evolution took place in the family at some time in the past and was followed by widespread extinction, leaving many genera isolated from their near relatives and resulting in a group that is, at the same time, clearly natural and extremely diverse. That time of rapid evolution seems to have taken place — at least in the Greater Antilles — during the upper Miocene time, characterized by both climate changes and geological events.

Neomazaea Krug et Urb. is known as a subendemic Cuban genus, with two endemic species in Cuba and one in Haiti. All the polytypic endemic and subendemic genera of Cuba have a notable commun feature. Their species are very closely related to each other in morphological point of view. *Neomazaea* Krug et Urb. would be an interesting exception. *N. phialanthoides* (Griseb.) Kr. et Urb. and *N. tinifolia* (Griseb.) Urb. are surprisingly different for being sympatric serpentinicolous species of the same genus. This phenomenon made us to suspect weather the two mentioned species could be really classified into *Neomazaea*.

In order to recognize the morphology and structure of the pollen grains of the Cuban *Neomazaea* species and to find pollen morphological evidences supporting their taxonomical segregation M. JÁRAI-KOMLÓDI and M. MONCADA carried out the following studies.

The pollen morphology of Neomazaea with reference to taxonomy

Since the recognition exists that fossil pollen grains, as direct evidences, take us nearer to understand the origin and evolution of the flowering plants, there is an urgent need to obtain sufficiently correct knowledge of modern pollen morphological data.

That is why in recent years there has been a significant awakening of interest in the evolution of aperture and exine structure in different Angiosperm families.

Rubiaceae seems to be very suitable for palynological studies. This is a rich family with several hundreds of genera and species, and has a remarkable ecological, economical and taxonomical importance. Finally, it is heterogeneous enough from palynological points of view.

Rubiaceae has great pollen morphological diversification manifested in several features. As to the structure of the apertures there is a morphological advancement from the porate and there is often a gradual transition among them: colpate, colporoidate, colporate, colpoidorate, porate. Even the pollen grains belonging to the colporoidate and colpoidorate exhibit different

features in their details. Not only the character of the apertures but also their number is varied from non- to poly-aperturate. Similary, the exine structure shows a remarkable morphological variation, as well: tectate, semitectate, intectate.

In any case, *Rubiaceae* family is little known palynologically, so far. To get complete picture, more detailed, further study is needed.

Material and methods

The polliniferous materials was collected in the field during the botanical expeditions. The material for light microscope investigation was acetolyzed according to ERDTMAN's method (1960). The microscopic investigations have been carried out with a Zeiss Amplival microscope. Micrographs were made by J.-KOMLÓDI with a Zeiss NV light microscope. Terminology mainly follows that of ERDTMAN.

Pollen grains descriptions based upon light microscopy

Neomazaea phialanthoides (Gr.) Krug et Urb., Loma Peluda, P. del Rio, 11/74; MONCADA 1461 HAC (Pl. I. Fig. 1—18).

Pollen grains 4—5 colporoidate, the inner part of the composite aperture similar to an os, NPC (4) 545, oblate spheroidal-prolate spheroidal, 13.3—16.9×14.5—18.1 μ. Amb quadrangular, ora lalongate 1.8—2.6 μ in diameter. Crassimarginate and somewhat more then twice as thick as nonapertural part of exine. Colpi about 2/3 of the radians. Exine 1.8—2.5 μ thick. Sexine 1.4—2.0 μ thick, semitectate. Sexine reticulate (heterobrochate). Muri about 0.3 μ wide, simplibaculate. Bacula from 0.9—1.6 μ long, diameter 0.2—0.6 μ. Lumina from 0.2—0.7 μ in diameter.

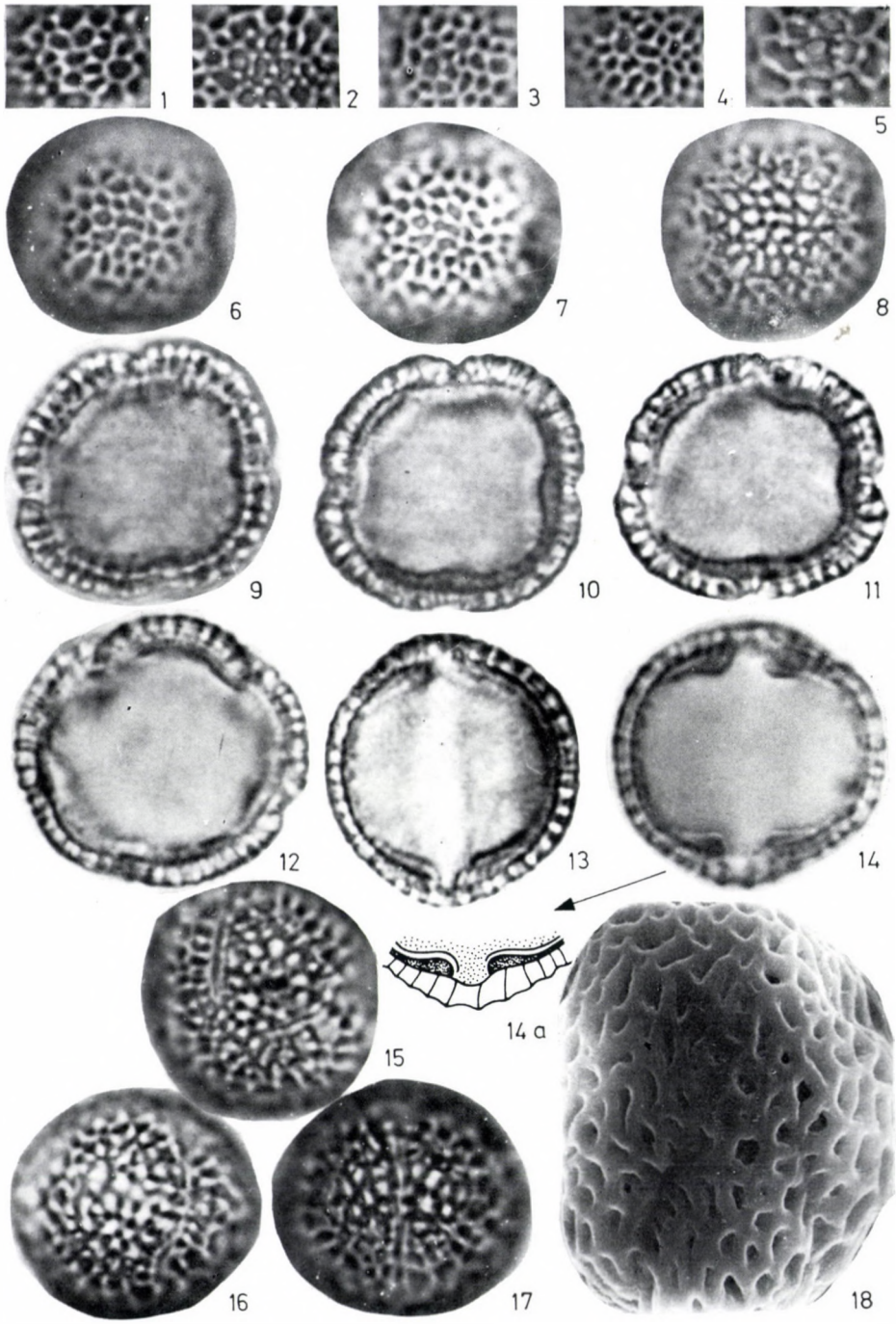
Neomazaea tinifolia (Griseb.) Urb., Pelo Malo, Las Villas, 6/74; ANGULO et ALFONSO 1472 HAC (Pl. II, Fig. 1—12).

Pollen grains 3 colporate, NPC 345 (brevicolpate) oblate spheroidal 18.1—26.6×19.3—29.0 μ. Amb circular, ora lalongate from 4.6 to 6.6 μ in diameter. In the area of ora aperture crossimarginate and nearly twice as thick as the nonapertural part of exine. Exine 1.5—2.0 μ thick. Sexine about 1.5 μ thick, tectate. Tectum probably granulate. The very fine and irregularly arranged granules about 0.2 μ in diameter.

Plate I

Neomazaea phialanthoides (Giseb.) Krug et Urb.

1—5. Different features of sexine reticulum
6—11. LO pattern of a single grain from high focus (6) to low (11). Polar view
9—11. NPC 445
12. NPC 545
9—12. Colporoid apertures in polar view
13—14. Colporoid apertures in equatorial view. The thickened part of the inner layer of exine around the os is well visible
15—17. Colpi with narrow margins
18. Scanning electron micrograph. Magnification ca. ×3000
Magnification of all IM photos ca. ×2000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Pollen morphological comments with regards to taxonomy

The pollen grains in species recently belonging to *Neomazaea* do not exhibit common pollen morphological feature. The size, the shape, the aperture and the exine structure are different. These features do not show pollen morphological affinity between the two species. This would have a great significance in the taxonomic discussion of the genus *Neomazaea*.

The pollen grains in *N. phialanthoides* are 4—5 colporoidate, in *N. tinifolia* are 3 colporate. The exine of the pollen grains in *N. phialanthoides* is reticulate, in *N. tinifolia* is granulate. These features encountered in the genus *Neomazaea* seem to give enough reason to support a segregation of *Neomazaea*.

Conclusion

As the final conclusion of the above enumerated arguments, *Neomazaea tinifolia* (Griseb.) Urb. can not be maintained anymore as a *Neomazaea* and we have to consider it as a type species of a new genus. The authors of this paper wish to dedicate this new genus of *Rubiaceae* to the memory of the great Cuban botanist and agronomist Julian ACUÑA GALE in occasion of the 80th anniversary of his birth.

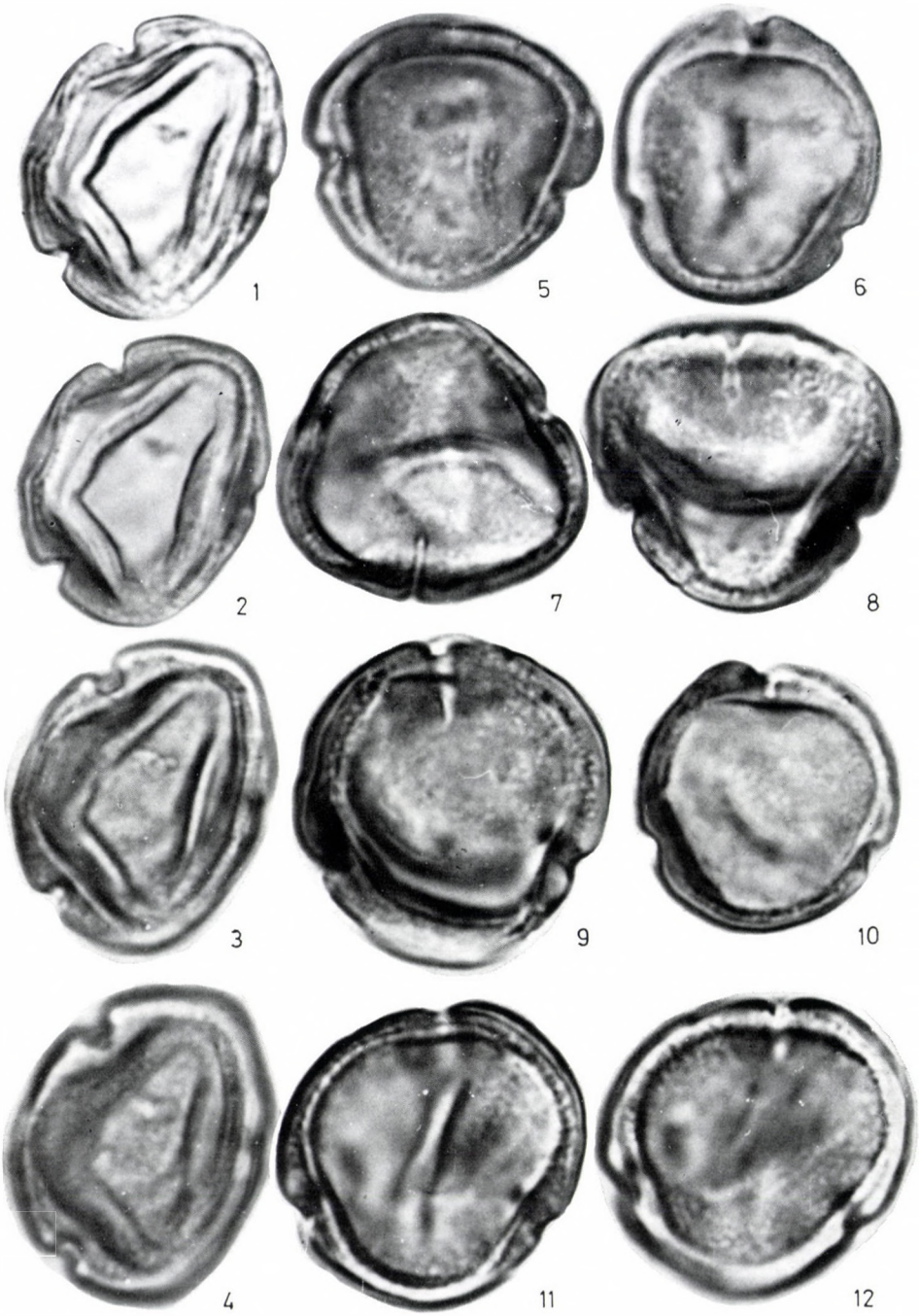
ACUNAEANTHUS* Borhidi, J.-Komlódi et Moncada **genus novum.**

Frutex cubanus. Stipulae interpetiolares acuminatae, persistentes. Folia ± longe petiolata, opposita. Flores in cymis simplicibus pedunculatis axillaribus vel in cymis paniculatis terminalibus. Cymae triflorae, flos centralis sessilis, bracteae binae oppositae, basi breviter connatae, persistentes. Calycis tubus turbinatus, leviter 4-costatus, obovatus, lobi 4, rotundati, crasse carnosi, glabri, resiniferi, in sicco valde plicati. Corolla anguste infundibuliformis, longe tubulosa, tubus intus superne hirsutus, fauce villosus, anellum fauciale absens; lobi 4, pulverulenti, non crasse carnosi. Antherae sessiles, oblongo-ellipticae, dorsifixae, filamenta brevissima vel nulla. Granum pollinicum 3-colpatum, brevicolpatum, late

Plate II

Acunaeanthus tinifolius (Griseb.) Borhidi
1—4. LO pattern of the apertural area of a single grain
5—6. Optical sections of the thickened (crassimarginate) exine area around the ora
7—12. Narrow short colpi (brevicolpate) and finally granulated tectum is visible
Magnification of all photos ca. ×2000

* Acunae is the genitiv case of Julian ACUÑA GALE's first family name; anthus is the latin form of the greek word: anthos = flower.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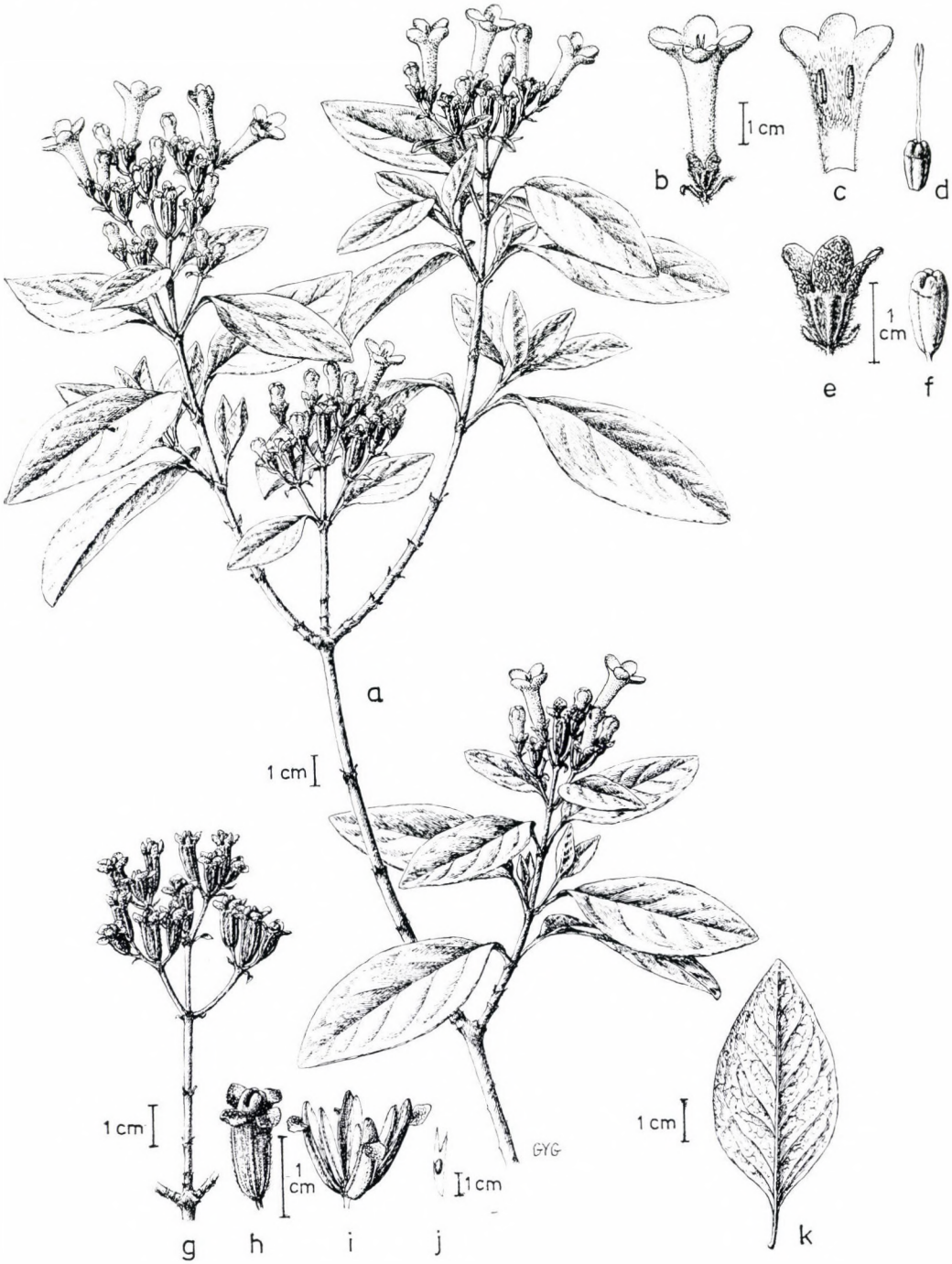

Fig. 1. Acunaeanthus tinifolius (Griseb.) Borhidi *a)* habitus, *b)* flower; *c)* corolla in longitudinal section; *d)* ovary with style; *e)* calyx; *f)* ovary with disc; *g)* infrutescence; *h)* mature fruit; *i)* opened capsule, *j)* seed; *k)* leaf beneath (Delined by Gizella GYURKÓ)

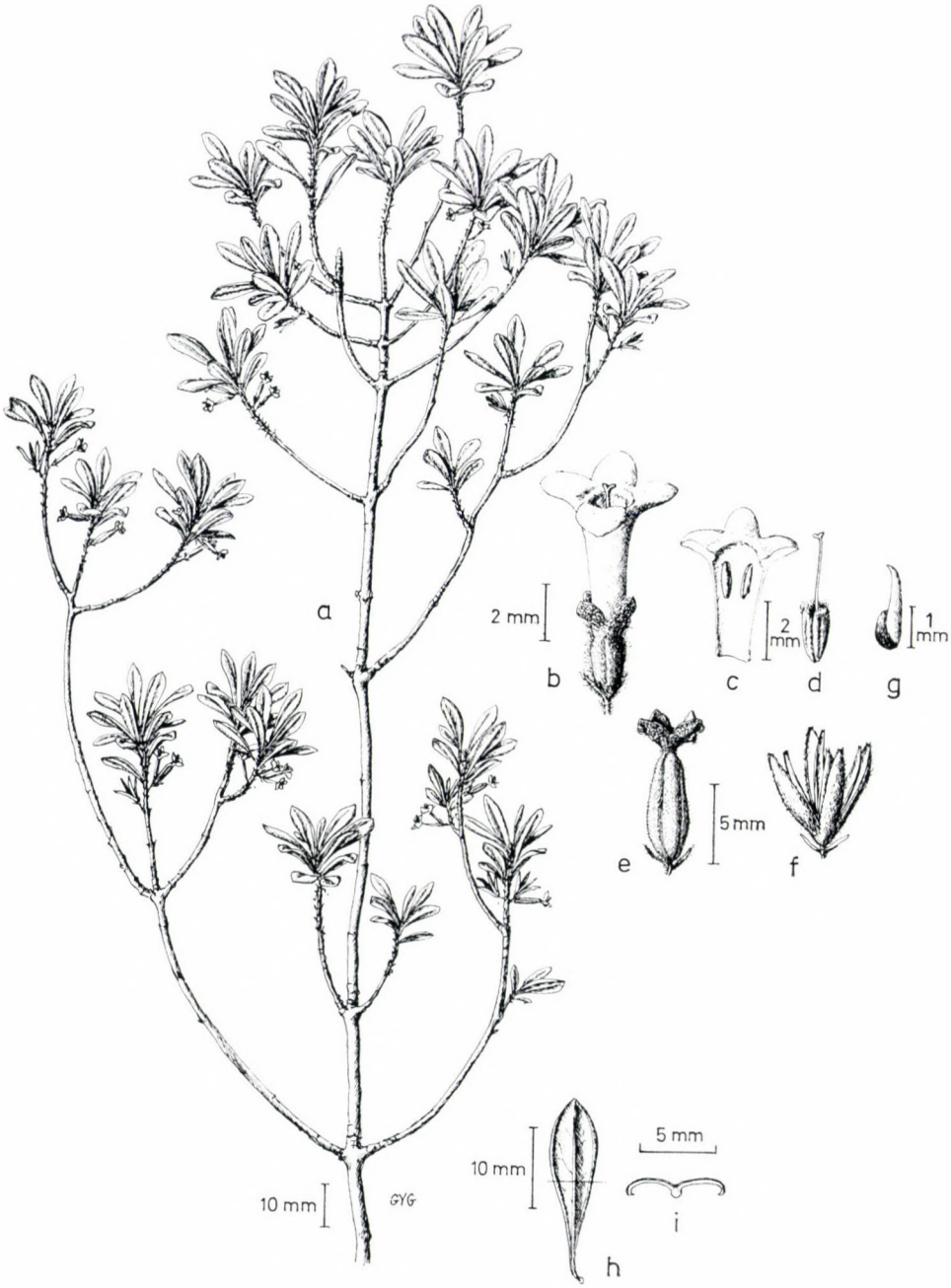

Fig. 2. Neomazaea phialanthoides (Griseb.) Krug et Urb. *a)* habitus; *b)* flower; *c)* corolla in longitudinal section; *d)* ovary with style; *e)* mature fruit; *f)* opened capsule; *g)* seed; *h)* leaf beneath; *i)* leaf in transversal section (Delined by Gizella GYURKÓ)

globosa, ambitu circulari, apertura crasse marginata; exine 1.3–1.8 μm crassum, nexine ± 1 μm crassum, tectatum, superficie granulata. Stylus longe bilobatus. Ovarium obovatum, 2-loculare, discus annularis crassus, 2-lobatus, 2-partitus, glaber, placenta peltata in sectione transversali semiorbicularis, areolatus, 15—30-ovulata. Capsula lineari-oblonga, acute 4-angularis, lignosa, septicida, valvae postremo 2-partitae, lobis calycibus persistentibus; placenta lignosa, semina orbicaria vel elliptica, bialata, 10—25 in quoque loculo.

Typus generis: *Rondeletia ? tinifolia* Griseb. Cat. Plant. Cub. Lipsiae, 1866: 129. = **Acunaeanthus tinifolius** (Griseb.) Borhidi **comb. nova**

Synonyma: *Neomazaea tinifolia* (Griseb.) Urb. Ark. för Bot. 21. A. No. 5. 1926: 70; — *Exostema leonis* Standl. Publ. Field. Mus. Hist. Nat. Bot. Ser. 8. 1931: 338.

This genus as for actual knowledge is a monotypic one, endemic to Cuba, living exclusively on utrabasic rocks of serpentine, in pine forests, pine woodland, dry evergreen scrubs of the Provinces Pinar del Rio, Villa Clara y Sancti Spiritus.

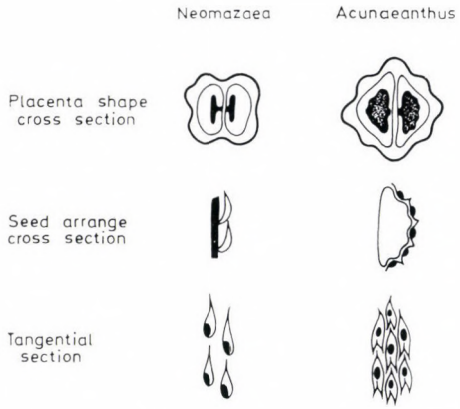

Fig. 3. Features of ovary structure in *Neomazaea* and *Acunaeanthus*

Neomazaea Krug et Urb.

Frutices vel arbores parvae. Stipulae interpetiolares, triangulares, acutae, persistentes, folia opposita, brevissime petiolata, coriacea. Flores solitarii axillares, bracteolae 2, minutae, caducae. Tubus calycis anguste oblongatus leviter 4-angulatus, supra ovario productus, lobi 4, rotundi con tubo sericeo-pilosi, non carnosi ni resiniferi, in fructu supra ovarium circumcisi et decidui. Corolla anguste infundibuliformis, tubus intus glaber, fauce anellum carnosum incrassatum gerens, lobi 4, imbricati, carnosi. Antherae 4, dorsifixae, oblongo-lineares, obtusae et inclusae, filamenta crassa antheris breviora. Granum pollinicum 4—5 colporoidatum, late globosum, ambitu 4-angulare. Exine 1.8—2.5 μm crassum, sexine 1.4—2.0 μm crassum semitectatum, reticulatum. Stylus filiformis, glaber, apice brevissime bidentatus. Discus annularis bilobatus, vertice pubescens; ovarium oblongum, biloculare, leviter costatum, placenta peltata compressa, ovula 2—4 in quoque

loculo. Capsula oblongo linearis, vel oblongo-elliptica, apertura septicida, valvae 2-partitae. Semina 2—4, lineal-lanceolata, apice acuta, basi obtusa et incrassata, funiculo subbasali suffulta.

Typus generis: *Rondeletia phialanthoides* Griseb. Cat. Plant. Cub. 1866: 129.

Mazaea phialanthoides Krug et Urb.

Neomazaea phialanthoides (Griseb.) Krug et Urb.

ACKNOWLEDGEMENTS

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NICHE STUDIES ON SOME PLANT SPECIES OF A GRASSLAND COMMUNITY, VII*

QUANTITY AND SEASONALITY OF PHOTOSYNTHETIC PIGMENTS. SPRING

By

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Investigations were carried out on the photosynthetic pigments (carotene, chlorophyll-a, chlorophyll-b, xanthophylls) of seven species of a perennial sandy grassland community. Thin-layer chromatography was used and the investigations were repeated seven times according to species.

With this it was hoped to ascertain the level of the light-pigment ecological tolerance of the species and the degree of their similarity. The large variability in the concentration of photosynthetic pigments within a species can be attributed to the effects of the habitat; the variability in the relative values (referring to global pigment content) are much less. Based on the generalized distance calculation it could be determined that *Thymus* sp. and *Festuca vaginata* overlap most of the species, so these are the most generalists with respect to pigment-ecology. On the other hand, *Potentilla arenaria*, *Euphorbia seguieriana* and *Poa bulbosa* are ecological specialists.

Introduction

The arrangement of dominant-abundant species of the perennial sandy grassland community (*Festucetum vaginate danubiale*) in two-dimensional niche-space (soil-moisture and root-depth) and in three dimensional one (soil-moisure, root-depth, cover of dominant species) has already been dealt with (FEKETE et al. 1976, PRÉCSÉNYI et al. 1977a, b, 1979). We completed these investigations with a new approach in 1978/79: we began to examine the light-photosynthetic ecological tolerance.

Describing water ecology was carried out by measuring the environment, but light-measuring series were not done. In the case of soil moisture a remarkable variability was derived from the microrelief relations, from the closure of the vegetation changing point-by-point, but this was not expected with respect to light as the community's architecture is simple and its vertical stratification is poor. We have no data or evidence — but neither the contrary — referring to the fact that every population of the unistratal community gives the same light-ecological reactions. However, we know well, that the community is well-stratified in time (see phenophases, life forms, KÁRPÁTI and KÁRPÁTI 1954); the populations are very dissimilar morphologically-anatomically, and they show diversity in the photosynthetic pathways (types of C_3 and C_4 species are present as well as transitional ones — HORÁNSZKY and NAGY 1977). That is why we express the measure of light-ecological tolerance of populations, degree of their similarity, etc. with a complementary ecophysiological feature, that is the quantity of photosynthetic pigments. This can be done all the more so, because in

* Tece studies No. 20.

contrast with most of the former pigment-examinations, we have worked with the total spectrum of the photosynthetic pigments.

The measurements were taken in three seasons, but in this study only the spring-analysis results will be dealt with.

Material and method

In the 1979 spring aspect of the community *Festucetum vaginate danubiale* we examined the following species: *Festuca vaginata*, *Potentilla arenaria*, *Thymus* sp., *Euphorbia seguieriana*, *Poa bulbosa*, *Carex stenophylla* and *Muscari racemosum*. Photosynthetic pigment investigations were repeated seven times with the species. The seven repetitions meant seven different individuals of the actual species' population in all the examined species.

With respect to the sampled individuals the tuft-forming (*Festuca vaginata*) and polycormon(ramet)-forming (*Euphorbia seguieriana*) species were especially kept in view. At every sample the following was the essential stand point: the individuals must be present in the sample according to the different age parts of the plants. This is of special importance in the spring-aspect, where overwintering and young assimilating surfaces live and work together in some species.

The photosynthetic pigment investigations were based on MARÓTI and GABNAI (1971) thin-layer chromatographic method. The samples were taken during the early morning hours, and the pigment-amounts referred to mg/g dry-weight depending on the measured extinctions with the help of the HAGER—MEYER-BERTENRATH (1966) formula. In this way the following types of pigments were determined: carotene (α and β together), chlcrophyll-a, chlorophyll-b, luthein + antheraxanthin, violaxanthin, neoxanthin and zeaxanthin. Summarizing the concentration values of the xanthophylls with approximately the same character we could set up 4 main pigment groups (carotene, chlorophyll-a, chlorophyll-b, xanthophylls). In an other study we will deal with the detailed analysis of different species' pigment-formations in connection with ecological factors.

Results and discussion

Pigment concentrations and their variability

Examining the averages based on the 7 repetitions (Tables 1—7) it can be seen, that *Poa bulbosa* has the greatest concentration among all the 4 pigments. The variability of averages is the smallest in chlorophyll-a, and the greatest in chlorophyll-b. Making seven repetitions with the same species there was a considerable standard deviation of pigment concentration. *Euphorbia seguieriana*, *Potentilla arenaria* and especially *Muscari racemosum* (Table 8) is considered to be a relatively conservative species because of the four pigment CV-values. The greatest variability appeared in *Thymus* sp. *Festuca vaginata* behaved in a different way: only the variation coefficient value of chlorophyll-b is high.

Looking at the basic tables it is remarkable that some repetitions produced fairly dissimilar values compared to the average — whether down or up — in the case of all the four pigments. An excellent example of this are the 4th, the 5th, the 6th repetitions with *Poa bulbosa* (Table 5). With a simple calculation it turns out that the value of the pigment rates has already been fixed. This result can be well explained physiologically. In other words: there

Concentrations of photosynthetic pigments (mg/g dry weight)

Table 1
Festuca vaginata

	Carotene	Chl. a	Chl. b	Xanthophylls
	0.74	1.46	3.92	2.40
	0.97	1.29	0.57	3.49
	0.59	1.02	0.56	1.46
	1.37	1.93	1.33	2.13
	0.44	1.13	1.21	4.22
	0.74	1.52	0.54	2.48
	0.39	1.08	0.55	2.23
Average	0.75	1.35	1.24	2.63

Table 2
Potentilla arenaria

	Carotene	Chl.-a	Chl.-b	Xanthophylls
	0.538	1.441	0.518	1.053
	0.128	1.590	1.073	1.157
	0.151	0.697	0.353	0.827
	0.376	0.882	0.717	0.635
	0.413	1.137	0.470	0.698
	0.482	1.327	1.535	1.379
	0.267	1.982	1.286	1.481
Average	0.336	1.286	0.850	1.033

Table 3
Thymus sp.

	Carotene	Chl.-a	Chl.-b	Xanthophylls
	0.015	0.093	0.036	0.188
	0.877	1.357	0.699	4.455
	0.591	1.021	0.197	1.290
	0.783	4.995	1.842	4.285
	0.756	2.514	2.592	5.444
	2.754	6.347	6.014	9.289
	0.828	1.240	4.073	1.834
Average	0.943	2.522	2.207	3.826

Table 4

Euphorbia seguieriana

	Carotene	Chl.-a	Chl.-b	Xantho-phylls
	1.366	1.738	1.618	7.934
	0.232	1.484	2.268	6.061
	3.205	2.285	1.284	6.588
	1.797	2.493	1.468	8.738
	3.324	3.140	2.826	8.922
	1.022	1.981	0.617	4.282
	3.024	2.553	1.504	5.493
Average	1.995	2.239	1.655	6.860

Table 5

Poa bulbosa

	Carotene	Chl.-a	Chl.-b	Xantho-phylls
	1.616	3.725	4.768	5.61
	1.449	6.271	5.074	3.69
	1.994	9.498	5.653	7.08
	5.035	10.090	12.349	23.12
	3.542	5.830	9.965	14.94
	0.381	0.424	0.690	1.12
	0.706	0.932	1.224	1.37
Average	2.103	5.252	5.674	8.133

Table 6

Carex stenophylla

	Carotene	Chl.-a	Chl.-b	Xantho-phylls
	0.496	3.449	2.282	3.164
	0.749	1.330	1.062	2.004
	0.987	3.592	4.845	4.476
	1.334	4.520	2.247	3.488
	0.492	2.085	1.101	3.033
	0.789	1.053	0.509	2.174
	0.213	0.644	2.446	3.966
Average	0.722	2.381	2.070	3.186

is a correlation between the photosynthetic pigment concentrations of a species. This kind of connection can also be found in the seven species — taking the averages of Tables 1—7.

If we express the relative pigment-values then the variability will be reduced to a great degree (percentage values referring to the sum of the pigments). So the CV-values will be as follows in *Poa bulbosa* (in the bracket

Table 7

Muscari racemosum

	Carotene	Chl.-a	Chl.-b	Xanthophylls
	0.396	1.305	0.595	1.96
	0.371	0.783	0.244	1.73
	0.319	1.021	0.498	1.76
	0.286	1.413	1.659	1.32
	0.619	1.606	1.231	2.16
	0.531	1.539	0.810	2.29
	0.414	1.927	0.872	3.23
Average	0.419	1.370	0.844	2.06

the coefficients of variation of the absolute concentration can be seen): carotene 28 (78.17); chlorophyll-a 38.2 (72.6); chlorophyll-b 8.68 (39.66); xanthophylls 31 (99.52) %. But in spite of these we do not use the relative values with the view that there are considered to be rather a general, physiological parameter while the habitat-environmental effects can be studied more directly in absolute concentrations. We can analyse the pigment variability in an other respect, with the help of the pigment diversity values. That the pigment diversity varies for each species can be attributed to the fact that the mentioned pigment ratios are specific. The pigment diversity was calculated on the concentration averages (Tables 1—7) with the SHANNON formula (Table 9). If a pigment is much more expressed than the other this decreases the pigment diversity value. In this case it is probable that we have met a species which has become specialised with respect to light ecology. This is equivalent to a narrow niche breadth species (or its special position). In this sense *Potentilla arenaria*'s niche breadth is the biggest and *Euphorbia*'s the smallest. Examining the evennes based on redundancy R (MARGALEF 1957) gives roughly the same result, too:

$$E = 1 - R, \text{ where } R = \frac{H_{max} - H_{obs}}{H_{max} - H_{min}} \text{ (Table 10).}$$

Table 8

The CV% (Coefficient of Variation) values of photosynthetic pigments in species examined

	Carotene	Chlorophyll-a	Chlorophyll-b	Xanthophylls
Festuca vaginata	45.16	23.70	99.16	35.13
Potentilla arenaria	47.06	33.82	53.44	31.69
Thymus sp.	90.22	91.43	100.10	80.35
Euphorbia seguieriana	60.60	24.50	42.89	25.37
Poa bulbosa	78.17	72.60	39.66	99.52
Carex stenophylla	50.69	62.34	69.26	28.21
Muscari racemosum	27.90	27.79	56.89	29.32

Table 9

Pigment diversity values

	H
Festuca vaginata	0.5578
Potentilla arenaria	0.5630
Thymus sp.	0.5589
Euphorbia seguieriana	0.5186
Poa bulbosa	0.5628
Carex stenophylla	0.5570
Muscari racemosum	0.5407

Table 10

Pigment evennes values

	R
Festuca vaginata	0.9245
Potentilla arenaria	0.9348
Thymus sp.	0.9282
Euphorbia seguieriana	0.8611
Poa bulbosa	0.9347
Carex stenophylla	0.9250
Muscari racemosum	0.8976

Similarity between species based on pigment spectra and the pigment structure of the community

One of our aims was to determine which species form similar or dissimilar pigment compositions; whether there have been such groups in which the examined species behave more or less uniformly with respect to the concentration of photosynthetic pigments. For this purpose we calculated generalized distance (D^2)-values between the species (by WEBER 1957; Table 11). It can be seen, that *Thymus* overlaps five, *Festuca* overlaps four other species (obviously all those belonged to the overlapped species at which the distance was not significant). We have already mentioned that the variability of the pigment concentration is the biggest in *Thymus* among all. That is why this one can be considered to be the most generalist species. Its opposites are: *Potentilla*, *Euphorbia* and *Poa*, because they do not separate only from one species each. *Muscari racemosum* and *Poa bulbosa* are similar in their seasonal rhythm (and life form, s.l.) but they separate on the basis of significant D^2-values.

For the sake of simplifying we made cluster analyses (average linkage clustering, SOKAL and MICHENER 1958) based on D^2-values. Results are given (in Fig. 1); we make the remark that we took the value of the last contraction on the axis of fusion dissimilarity as 100% and the value of the previous ones in the per cent of it. It was a surprising result, that *Festuca vaginata* — which is green in the total vegetation season, moreover: in all the 12 months — and the periodical *Muscari racemosum* show the greatest similarity and make up the centre of the cluster formation. It is true that at the end of the winter many new buds were formed on the *Festuca*, but perhaps most of the examined leaves did not overwinter. (*Poa bulbosa* joins the group of *Festuca-Muscari-Thymus-Carex* with a higher than 50 per cent fusion similarity.)

Table 11
D^2-analysis results

	Potentilla	*Thymus*	*Euphorbia*	*Poa bulbosa*	*Carex stenophylla*	*Muscari racemosum*
Festuca vaginata	2.678**	0.206	0.097	1.256*	0.41	0.043
Potentilla arenaria	—	0.172	5.813***	2.158**	2.316**	2.317**
Thymus sp.		—	1.836*	0.731	0.068	0.206
Euphorbia seguieriana			—	5.22***	3.46**	3.654***
Poa bulbosa				—	1.313*	2.303**
Carex stenophylla					—	0.840

* Significant at 5%
** Significant at 1%
*** Significant at 0.1% level

Euphorbia deviates from the group of six members to a great extent. The main reason for this is presumed to be due to the dissimilar xanthophyll formation. There seems to be a species which can be said to be a generalist

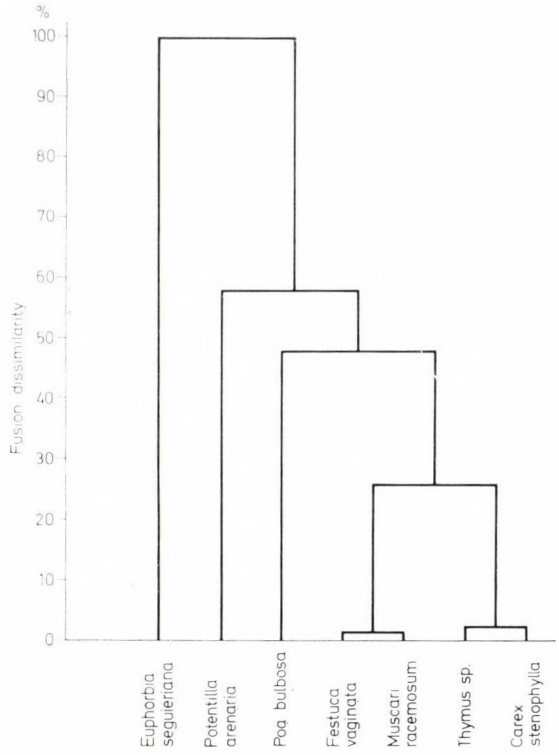

Fig. 1

one in respect of not only the water or its behaviour with the dominant species, but in respect of light ecology, too. This species is *Thymus* sp.

Anyway the greatly vertical articulation of the dendrogram is striking as is the forming of groups with strong and weak similarity. However, we do not have too much to go in explaining the results. For this it would be necessary to know the degree of pigment homeostasis of species and their seasonal lability. The validity of the similarity groups can only be determined in full knowledge of these. The evaluation of our measurements on photosynthetic activity can help in the interpretation.

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PLATANUS NEPTUNI (ETT.) BŮŽEK, HOLÝ ET KVAČEK IN THE HUNGARIAN OLIGOCENE

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Two new Hungarian localities of *Platanus neptuni* are recorded by the author after the Bohemian, the German, and the French ones. One record is from the Lower Kiscellian (Lower Oligocene) from the drillings H (Budapest); the other one is from the Egerian (Upper Oligocene) Verőcemaros (North Hungary). For the first time in Hungary examinations of epidermis have been performed besides detailed macromorphological investigations. The Hungarian data are compared with foreign ones, and ecological and climatological conclusions are drawn.

Introduction

In the 19th century ENGELHARDT (1885) collected remains from several palaeobotanical localities of Bohemia which were known under different names in the literature, but on the basis of modern investigations by BŮŽEK, HOLÝ and KVAČEK (1967) they belong to only one species. Since then an increasing number of remains, which had previously been known under different names, have been shown to belong to a very unusual, extinct species of the *Platanus* genus, to *Platanus neptuni*.

In the opinion of these authors this species is most closely related to *Platanus kerrii* of the recent platans, which has an extremely limited distribution and occurs in subtropical woods of Laos. The two species are, however, not identical and *Platanus kerrii* may not be derived from *Platanus neptuni* (KVAČEK 1971).

We need not be suprised, if we find specimens of this species under 24 different names from a single locality in the palaeobotanical literature (ENGELHARDT 1885), as it is extremely rich in forms and greatly differs from other well-known forms of *Platanus*. Revision of these probably has not yet been undertaken in many cases, thus this species is presumably even more widespread than shown by present data. In Hungary this species has been recovered in the course of earlier collections and occurs under varied names. Revision of these is being carried out.

Material and methods

The examined flora is deposited in the Palaeobotanical Collection of the Botanical Department of the Hungarian Natural History Museum: No. 78. 1. 1—78. 353. 1.; 79. 1. 1—79. 18. 1.

As I previously have given account of it, relatively many remains of *Platanus neptuni* have been found in drillings during recent excavations of Tard Clay (HABLY 1979). This species is described for the first time from Hungary, and as it is very rich in forms, the specimens could be identified only with tedious efforts in almost all cases by performing epidermis examinations. Preservation of the leaves is good, in most cases the epidermis remained intact.

In the morphological examinations the epidermis covers on the venation caused some difficulty. Most often it could be observed only on the counterproof free from epidermis, but rarely on ones bearing it. The age of the flora is Lower Kiscellian, consequently it belongs to the lower period of the double-divided Hungarian Oligocene: Kiscellian, Egerian.

The other examined flora containing *Platanus neptuni* is a collection made by Á. Boros in 1973. Its locality is Verőcemaros (North Hungary) (Fig. 1). Age of the flora is Egerian on the basis of A. Nagymarosy's nannoplankton examinations. The collection contains very few remains, but suprisingly the great proportion of which is *P. neptuni*. The flora was preserved in sandstone, nevertheless in the more clayey parts it is in excellent condition. The

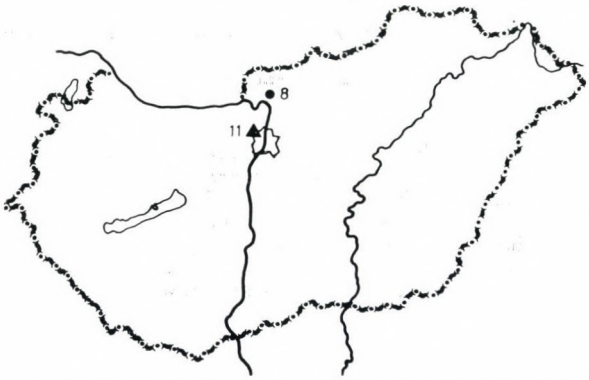

Fig. 1. Localities of *Platanus neptuni* in Hungary: 8. Verőcemaros, Egerian (Upper Oligocene); 11. Budapest, Tard Clay Formation, Kiscellian (Lower Oligocene)

material was not suitable for epidermis examinations, it could be identified only on the basis of gross-morphological marks. The examination is greatly hindered by the fact that it is the margin of the leaf which suffers the most damage and therefore the most characteristic morphological mark, the dentation is lost. Nevertheless, in some specimens, where the margin has remained, the mark of the species can be recognized without any doubt. On the other hand, inflorescence was found as well, indicating the presence of the species.

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček (1967) (Plate I—X)

Leaves small or medium sized and simple, breadth 0.9—3.3 cm, length 5—12 cm. Margin of the leaves whole for one third from the base. It is usually here where the dentation begins, which is the most distinct on the leaf-apex. Presence of the teeth on the two margins of the leaves often begins at different distances from the base, the difference between the two sides may be up to 0.5 cm. The base mostly slight, rarely strikingly asymmetrical. Two inflorescences were also found in flora of Verőcemaros, the length of one of which is 0.9 cm including the pedicel, diameter of its capitulum is 0.2 cm. The other one is slightly larger, 1.2 cm in length, diameter of its capitulum 0.4 cm. In most cases proper identification was confirmed by epidermis examination, and in this way several fragmentary or characterless basal remains could be determined.

Epidermis examination

The preparations were made by the well-known procedure without staining. As mentioned in the Introduction, the epidermis was preserved only in the Tard Clay flora. In several specimens no formation could be observed on

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the upper epidermis. In some specimens a cellular netting with undulate wall could be clearly seen, sometimes other structures, e.g. glands could be observed as well.

The lower epidermis abounding in formations, closely packed with anomocytic stomata, that are characteristic for the species. In almost all cases the undulate-walled cells clearly seen among the stomata. Stomata

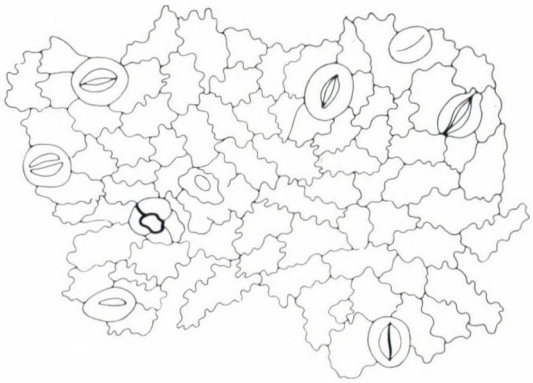

Fig. 2. Lower epidermis of *Platanus neptuni*

simple, with large, opened pores (Fig. 2). Hair bases frequent mainly on the venation or near to it, but may be found farther away as well. In most preparations round formations may be observed that are somewhat larger than the stomata, and usually consist of four, maximum six cells, and in some cases cover both the upper and the lower epidermis in large numbers. These are probably young gland cells. In some cases groups consisting of 3—10 cells can be observed that are cutinized to a higher degree than the surrounding cells. These formations are highly characteristic for the upper epidermis of some vein sections, where they are situated in the axis of the vein, markedly separated from the elongate, straight-walled cells covering the vein.

The lower epidermis of the vein differs strikingly from the upper one. It is made up of flat and quadrate cells, and not elongate, as in the upper epidermis, sometimes they are shorter along the axis than at right angles to it. Going abaxially, first elongate cells, then isodiametrical, undulate-walled cells form the epidermis. In two specimens a large, oval leaf-gland could be observed which was highly cutinized on its inner margin. The interior of one of these was entirely empty, the other one was filled with amorphous matter. The latter was surrounded on all sides by straight-walled, elongate cells, while surrounding the former, being on the primary vein, were not elongated to such a high degree. In any case these cells were narrower than the cuboid ones of the primary vein and some of them were polygonal.

Distribution of the species

On the basis of the present data the distribution of the species is characteristic for the Oligocene. The first specimens published by Engelhardt occurred from the Middle Oligocene of Kučlin (Bohemia), but the Egerian localities of the Czech Central Mountains (Kundratice, Suletice, Markvartice,

Fig. 3. Localities of *Platanus neptuni* in Europe. Carpathian (Miocene): 1. Plesná (ČSSR). Egerian (Upper Oligocene): 2. Varnsdorf (ČSSR), 3. Markvartice (ČSSR), 4. Kundratice (ČSSR), 5. Suletice (ČSSR), 6. Žichov (ČSSR), 7. Seifhennersdorf (GDR), 8. Verőcemaros (Hungary), 9. Bois d'Asson (France). Middle Oligocene: 10. Kučlin (ČSSR), Kiscellian (Lower Oligocene): 11. Budapest (Hungary). Eocene: 12. Haselbach (GDR). — ○ Carpathian (Miocene); — ● Egerian (Upper Oligocene); — △ Middle Oligocene; — ▲ Kiscellian (Lower Oligocene); — ■ Eocene

Žichov, Varnsdorf), as well as the Seifhennersdorf locality (WALTHER 1974) on the German side also abound in finds (BŮŽEK, HOLÝ and KVAČEK 1967). A locality aged Upper Oligocene is also known from the South of France: Bois d'Asson (KNOBLOCH 1973).

Its occurrence outside of Oligocene has been published so far, in the Carpathian stage of Bohemia (KNOBLOCH et al. 1975), and from the Eocene of Germany. In the Egerian of the Czech Flora it is a species of levelmarking value. The data from Hungary fit well into the present picture formed of the species. At present its occurrences are known from the Lower Kiscellian (Flora of the Tard Clay Formation) and from the Egerian (Verőcemaros)

(Fig. 3). Further localities will be revealed in the course of revisions but on the basis of studies so far they all are aged Oligocene. Accordingly, the species seems to have been widespread in the Oligocenes. As it was a continental species no difference may be found between the West Paratethys and the Central Paratethys and regions outside of the Tethys. While in the Oligocene the marine fauna was in the process of pronounced differentiation, the several continental floras were still in connection with each other.

Ecology and climatological requirements of the species

Of the recent members of the genus *Platanus*, *Platanus kerrii* is the one most closely connected — with *P. neptuni*. Which inhabits subtropical—tropical woods of the Himalaya to a height of about 1500 m. In the fossil floras *P. neptuni* was accompained by evergreen arborescent plants and drought-resistant species as well.

In contrast with other plants, it must have been a palaeotropical element (Bůžek 1971). In the Tard Clay Flora it occurs along with *Dryophyllum furcinerve* (Ross.) Schmal. *Zizyphus zizyphoides* (Ung. Endl.,) *Daphnogene bilinica* (Ung.) Knobloch et Kvaček, *Laurophyllum* sp., *Doliostrobus hungaricus* (Rásky) Bůžek, Holý et Kvaček, *Libocedrites salicornioides* (Ung.) Endl. to mention only the most important species. The Tard Clay Flora has a thermophilous and drought-resistant character (Hably 1979), whereas that of Verőcemaros shows no sign of drought resistance. In the latter, *Daphnogene bilinica* (Ung.) Knobloch et Kvaček, *Acer*, *Ulmus* and *Palma* occur along with the dominant *Platanus neptuni*. Arctotertiary elements form a very small proportion in the flora, thus it has a highly thermophilous character.

In view of the two above-mentioned floras, I agree with Knobloch's opinion (1973), that the species was attached to warm periods. He has proved this agreement by warm flora zones of Mai (1967). Accordingly the species seems to have been a thermophilous one but with respect to precipitation it showed greater tolerances. That the two floras existed under different climates is shown by the morphological differences between *Platanus neptuni* specimens of the two localities, respectively. Though size of the leaves shows great variance, nevertheless statistically, working with large samples, the range and mean of the samples indicate different conditions.

Table 1

Localities of *Platanus neptuni*	Minimum breadth	Maximum breadth	Mean breadth	Minimum length	Maximum length	Mean length
	cm					
Budapest Tard Clay	0.9	2.9	1.87	5.0	10.0	7.57
Verőcemaros	1.9	3.3	2.6	6.0	12.0	8.6

Summary

Recent localities of *Platanus neptuni* from the Oligocene show that the species lived in an optimal, warm subtropical climate in the Oligocene. It tolerated extreme rainfall conditions, which is indicated by differences in measurements of the leaves. In Tard Clay Formation, and also at the Verőcemaros locality it occurs as a dominant species, but because the latter flora contains a few specimens no farm-reaching conclusions may be drawn as regards its occurrence in Oligocene. In the lower horizons of the Oligocene, and also in the Lower Kiscellian in subtropical climate *P. neptuni* formed drought-resistant woody associations. In the Egerian it mainly occurred in association with evergreens, but also along with Arctotertiary elements.

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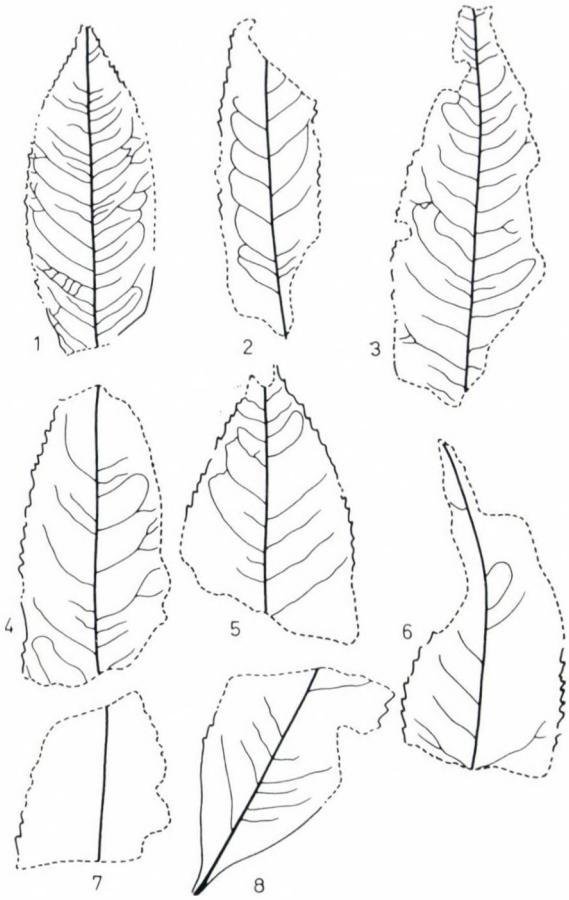


Plate I

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 79.10.1. Verőcemaros;
2. 79.12.2. Verőcemaros;
3. 79.16.1. Verőcemaros:
4. 79. 5.2. Verőcemaros;
5. 79. 9.2. Verőcemaros;
6. 79.12.2. Verőcemaros;
7. 79.19.1. Verőcemaros;
8. 79.16.1. Verőcemaros;

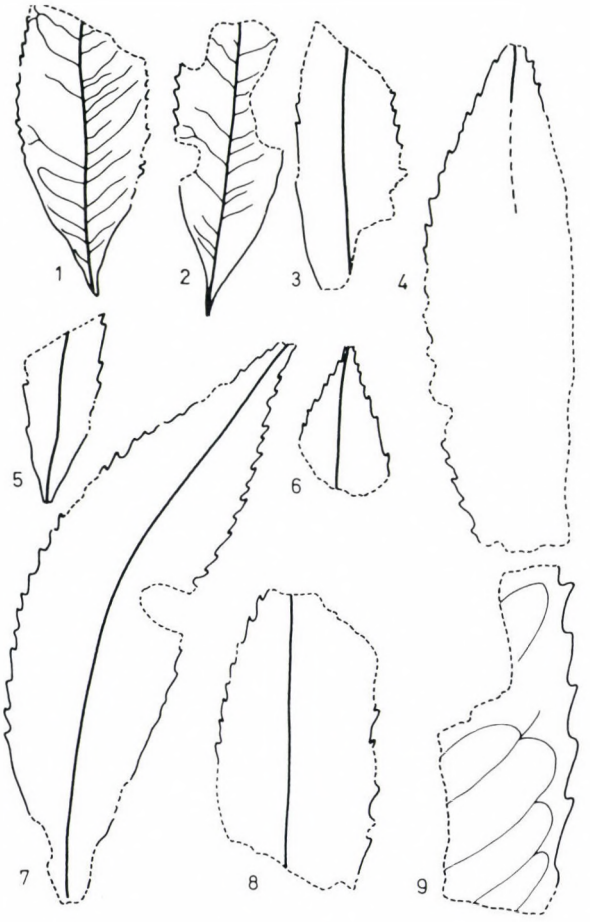


Plate II

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 79. 9.2. Verőcemaros;
2. 79. 14.1. Verőcemaros;
3. 78. 13.1. Budapest, Tard Clay Formation;
4. 78.343.1. Budapest, Tard Clay Formation;
5. 78. 7.1. Budapest, Tard Clay Formation;
6. 78. 15.1. Budapest, Tard Clay Formation;
7. 78.353.1. Budapest, Tard Clay Formation;
8. 78.296.2. Budapest, Tard Clay Formation;
9. 78.183.1. Budapest, Tard Clay Formation;

Plate III

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78. 13.1. Budapest, Tard Clay Formation;
2. 78.287.1. Budapest, Tard Clay Formation;
3. 78. 46.2. Budapest, Tard Clay Formation;
4. 78.308.1. Budapest, Tard Clay Formation;
5. 78.183.1. Budapest, Tard Clay Formation;
6. 78. 48.2. Budapest, Tard Clay Formation;

Plate IV

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.353.1. Budapest, Tard Clay Formation;
2. 78.316.2. Budapest, Tard Clay Formation;
3. 78.222.2. Budapest, Tard Clay Formation;
4. 78.296.2. Budapest, Tard Clay Formation;
5. 78.304.2. Budapest, Tard Clay Formation;

Plate V

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.301.1. Budapest, Tard Clay Formation;
2. 79. 12.2. Verőcemaros;
3. 78.343.1. Budapest, Tard Clay Formation;
4. 79. 10.1. Verőcemaros;
5. 79. 9.2. Verőcemaros;
6. 79. 12.1. Verőcemaros;

Plate VI

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78. 13.1. Lower epidermis, Budapest, Tard Clay;
2. 78. 48.2. Lower epidermis, Budapest, Tard Clay;
3. 78.112.2. Lower epidermis, Budapest, Tard Clay;
4. 78.112.2. Lower epidermis, Budapest, Tard Clay;

Plate VII

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.124.2. Lower epidermis, Budapest, Tard Clay;
2. 78.173.3. Lower epidermis, Budapest, Tard Clay;
3. 78.182.2. Lower epidermis, Budapest, Tard Clay;
4. 78.185.2. Lower epidermis, Budapest, Tard Clay;

Plate VIII

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.195.2. Lower epidermis, Budapest, Tard Clay;
2. 78.205.2. Lower epidermis, Budapest, Tard Clay;
3. 78.205.2. Upper epidermis, Budapest, Tard Clay;
4. 78.301.2. Lower epidermis, Budapest, Tard Clay;

Plate IX

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.301.2. Upper epidermis, Budapest, Tard Clay;
2. 78.308.1. Lower epidermis, Budapest, Tard Clay;
3. 78.308.1. Lower epidermis, Budapest, Tard Clay;
4. 78.308.1. Lower epidermis, Budapest, Tard Clay;

Plate X

Platanus neptuni (Ett.) Bůžek—Holý—Kvaček

1. 78.308.1. Lower epidermis, Budapest, Tard Clay;
2. 78.353.1. Lower epidermis, Budapest, Tard Clay;
3. 78.308.1. Upper epidermis, Budapest, Tard Clay;
4. 78.353.1. Lower epidermis, Budapest, Tard Clay;

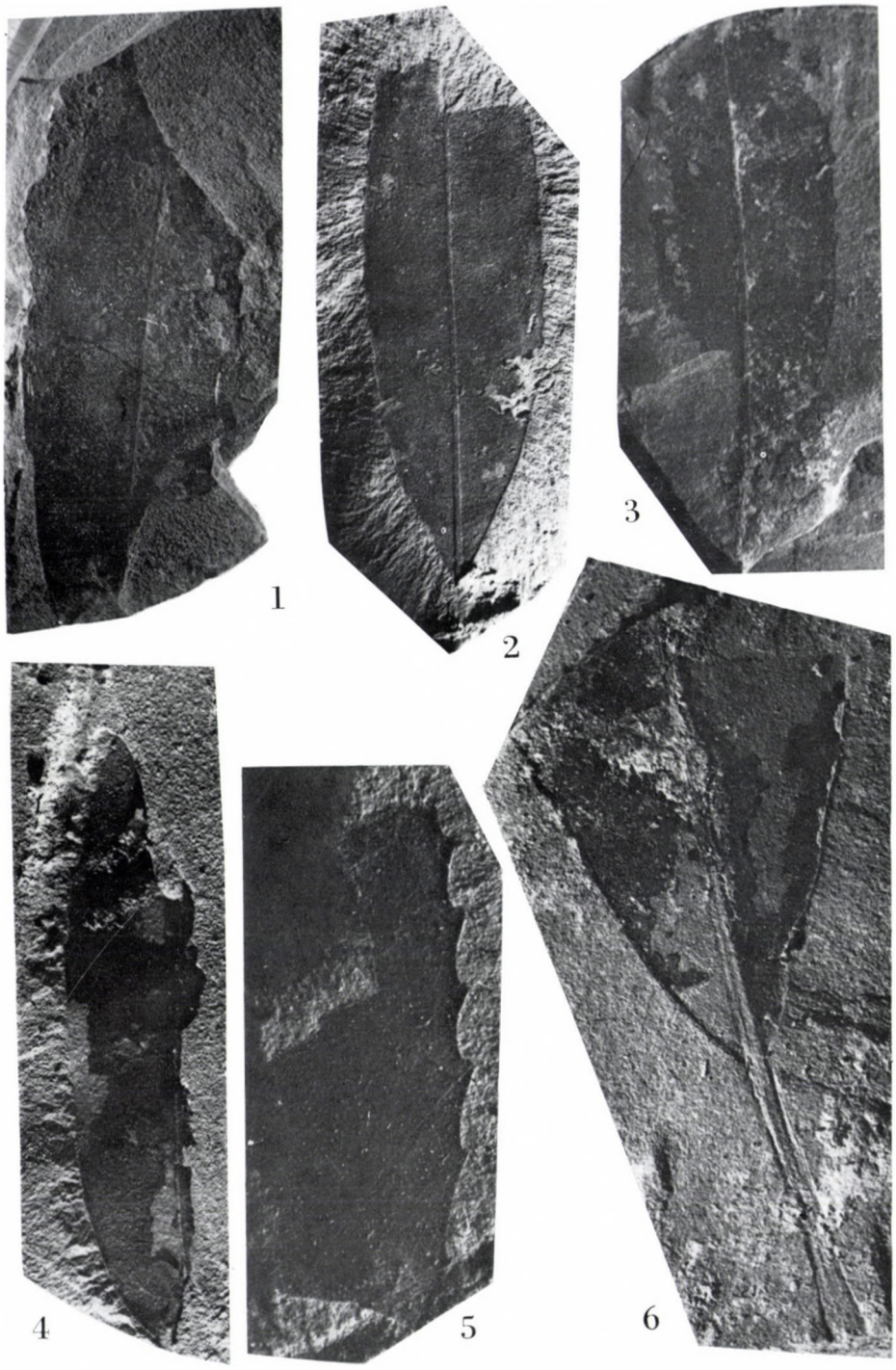


Plate III

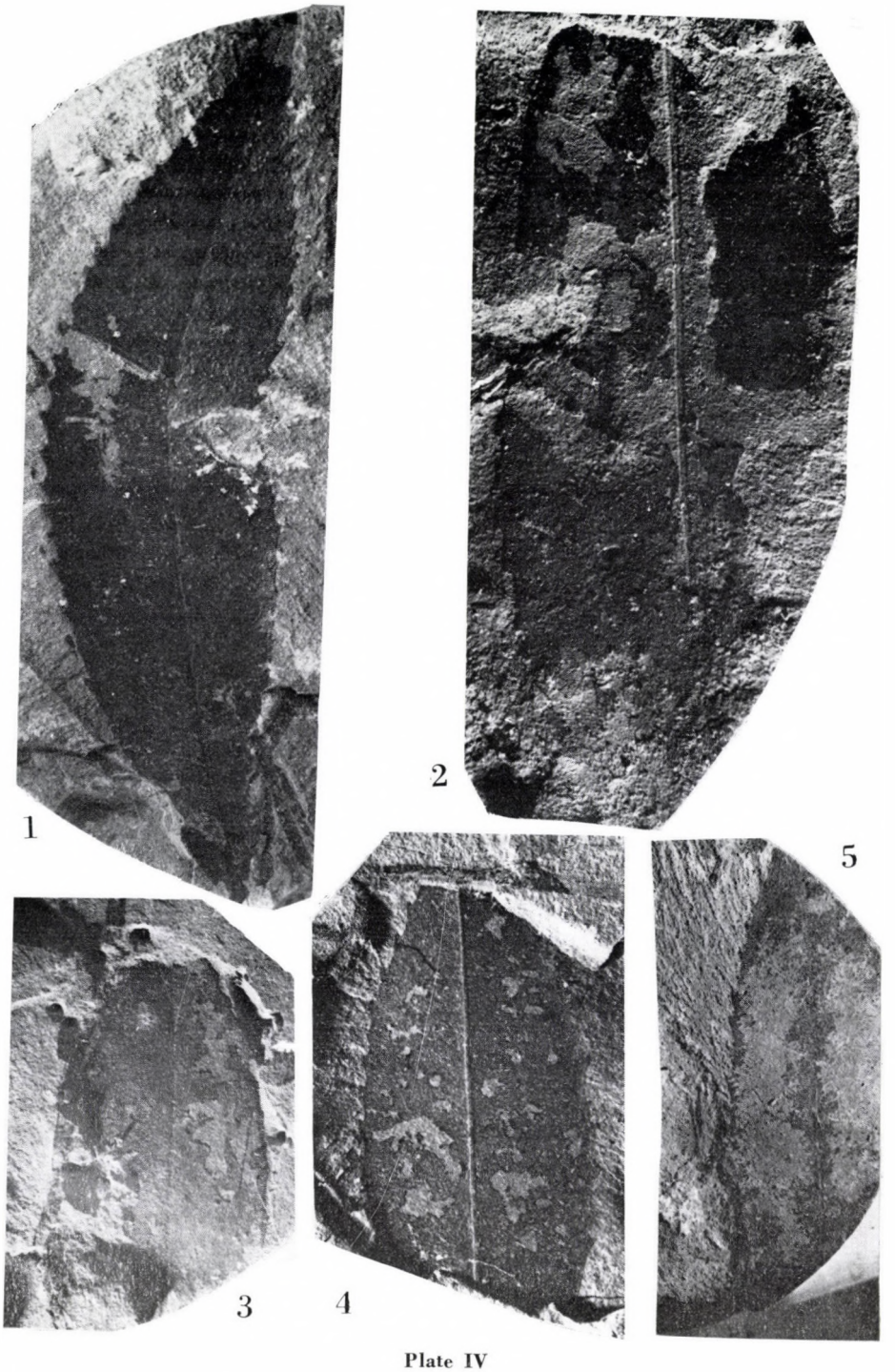
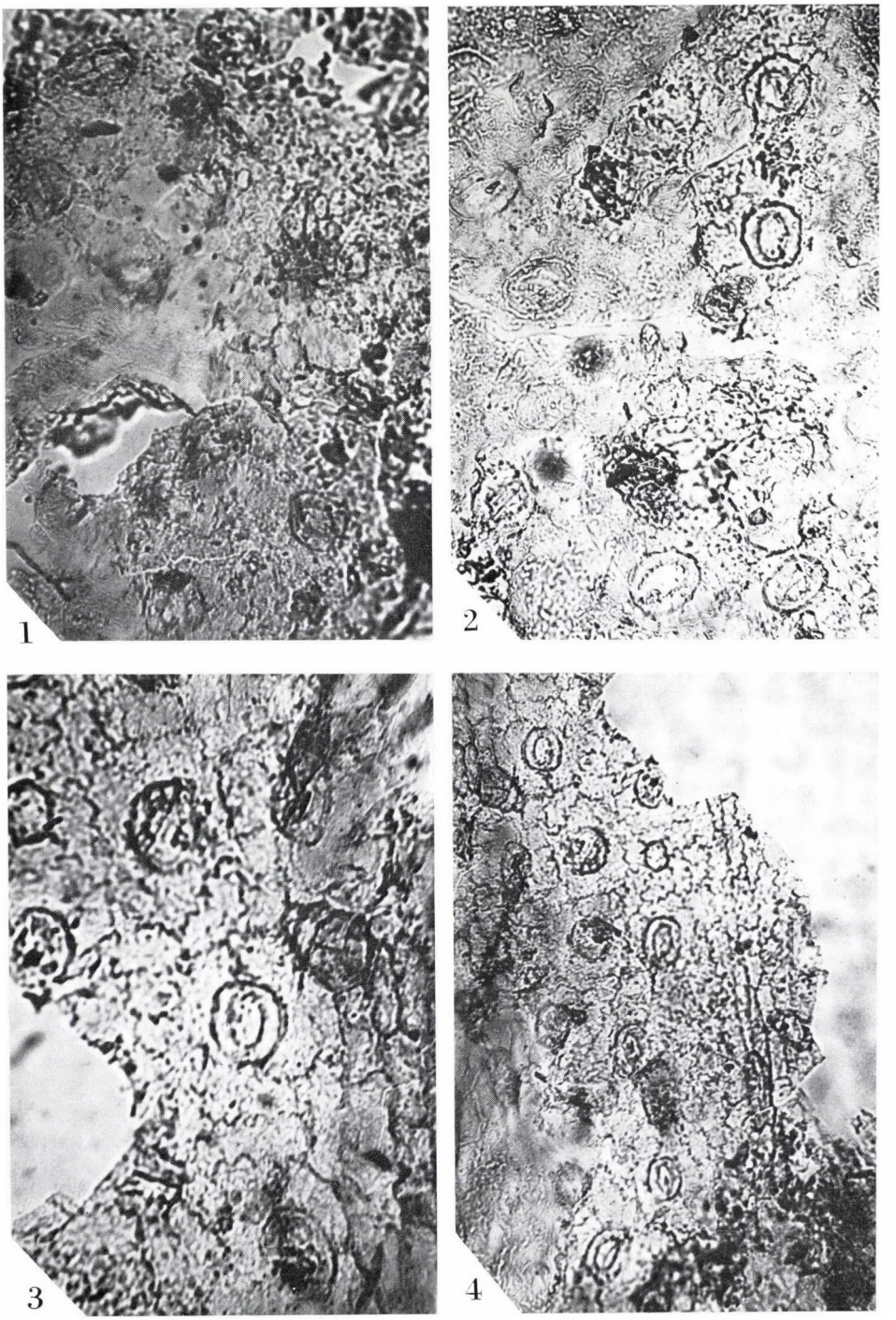


Plate IV

Plate V



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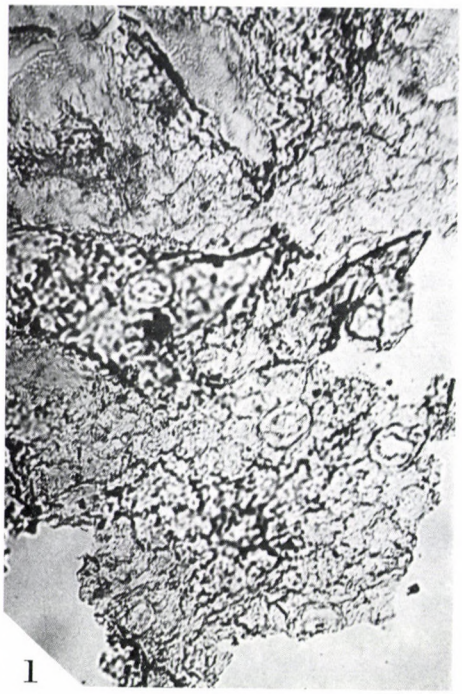

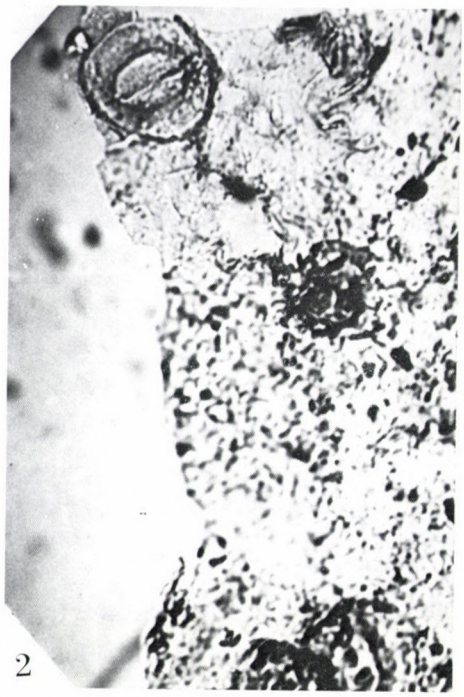

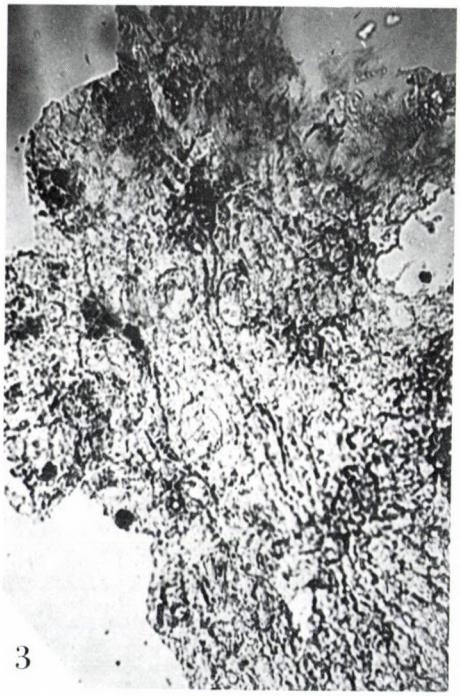

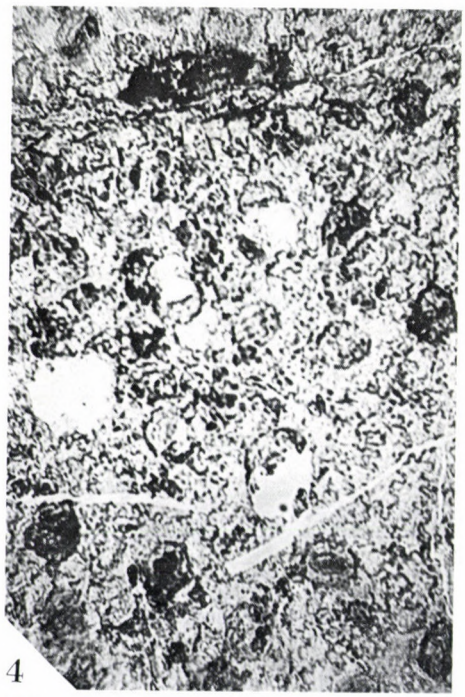

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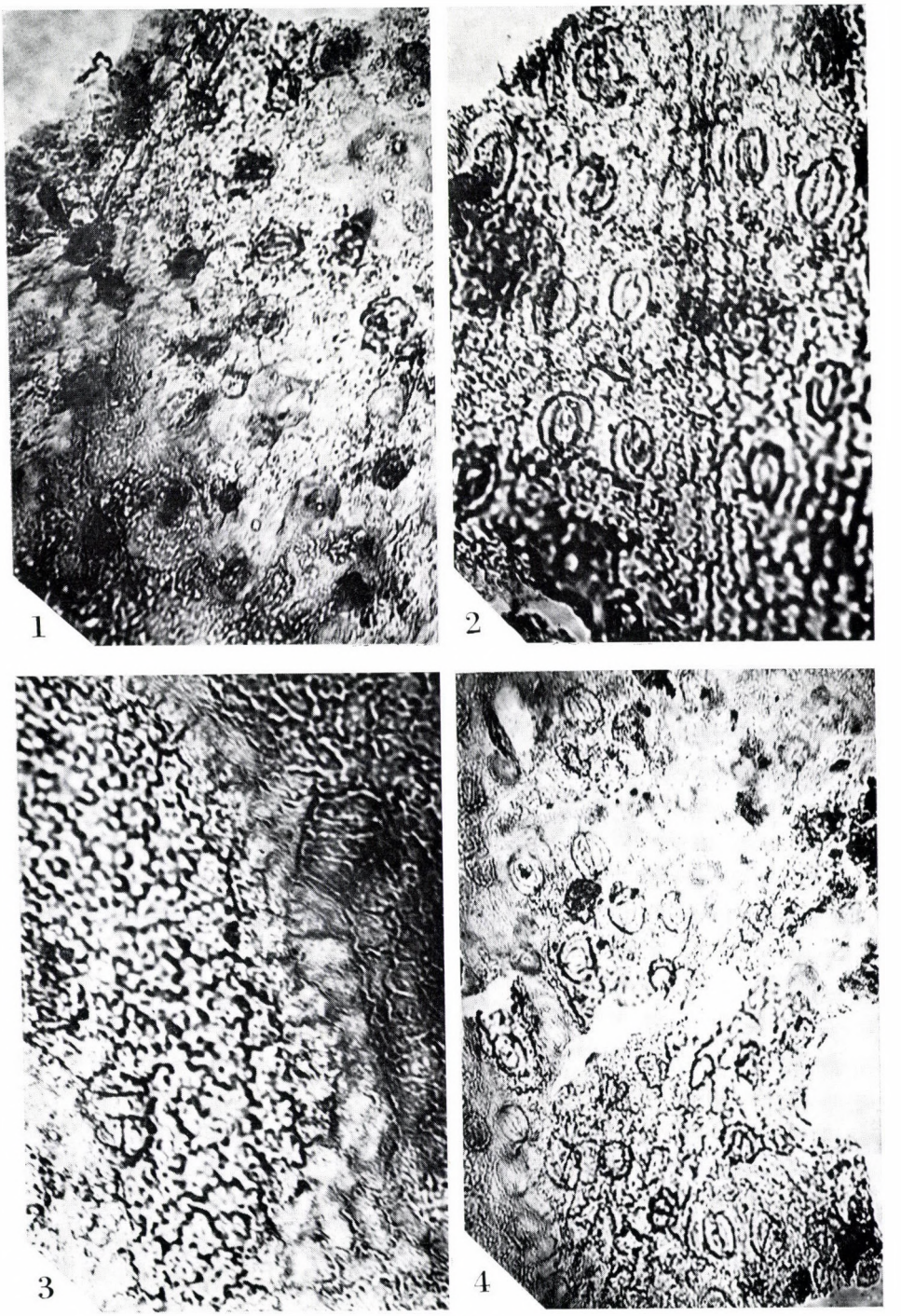

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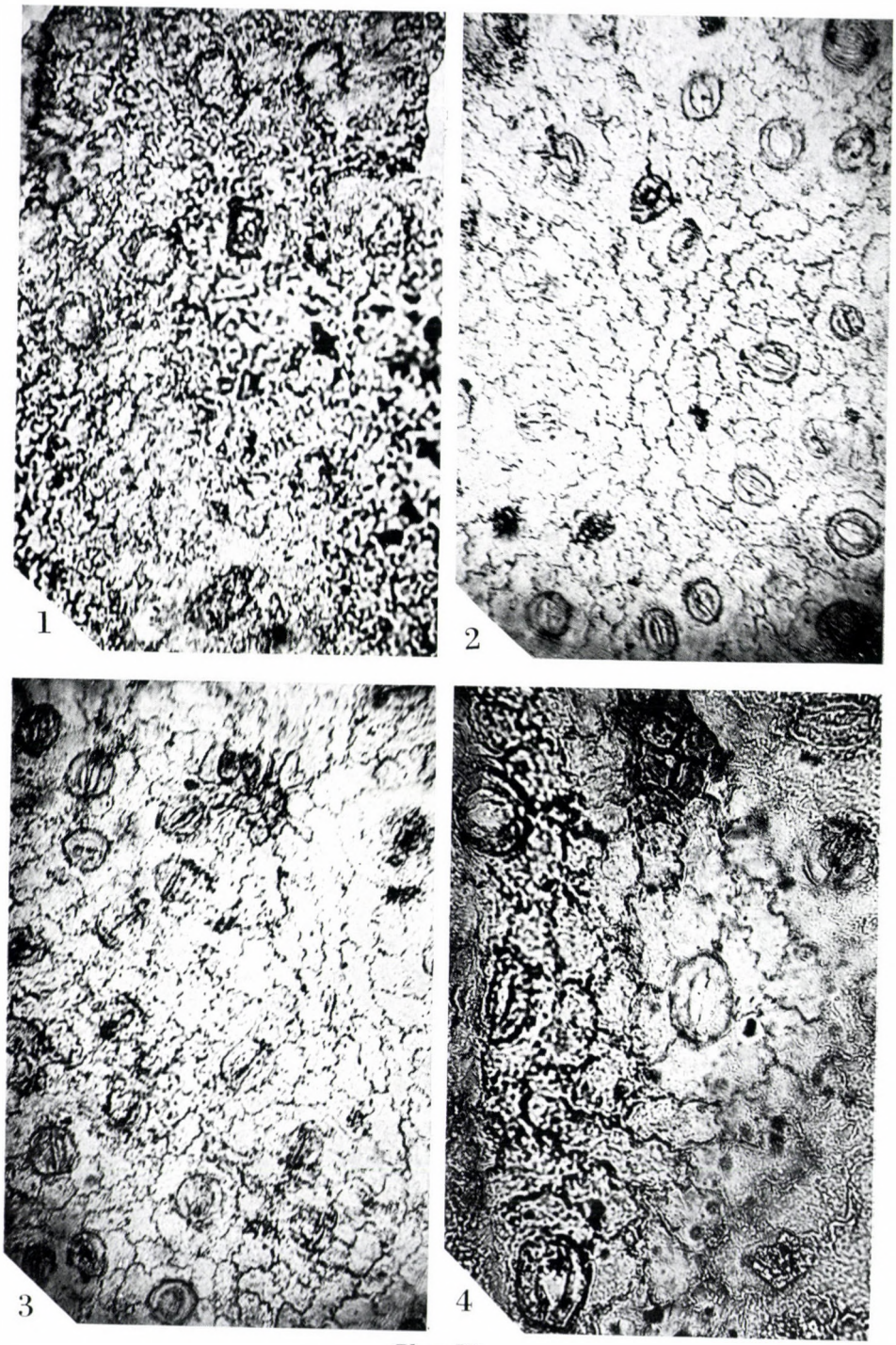

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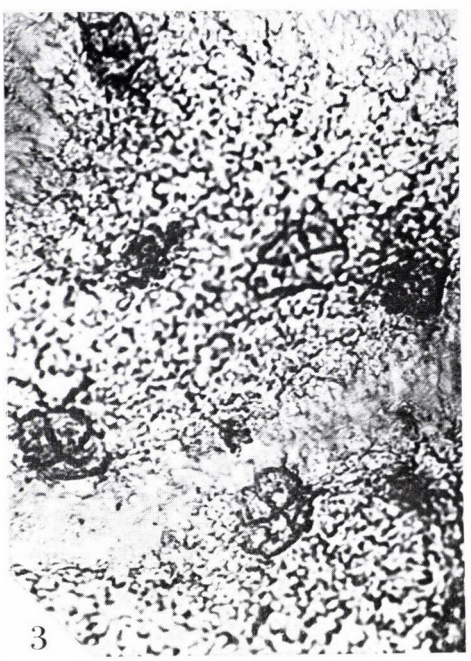

Plate X

Acta Botanica Academiae Scientiarum Hungaricae, Tomus 26 (3—4), pp. 317—337 (1980)

NEW *SCENEDESMUS* TAXA FROM THE BUDAPEST SECTION OF THE DANUBE

(BETWEEN THE 1588—1674 KMS)

By

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Author studied the Budapest section of the Danube from algological and bacteriological point of view during the years from 1970 to 1976. A considerable number of new microorganisms has been detected and described in some earlier publications. The present paper contains descriptions of 35 taxa of *Scenedesmus* (*Chlorophyta*), 4 species, 12 varieties and 19 forms, all new to science. They are the following:

Scenedesmus Kövesii, *Sc. longistriatus*, *Sc. pseudointermedius*, *Sc. saltator*, *Sc. carinatus* var. *brevicaudatus*, *Sc. ellipsoideus* var. *spinosus*, *Sc. intermedius* var. *crassibicaudato-granulatus*, *Sc. intermedius* var. *geminato-alternans*, *Sc. intermedius* var. *spinosiformis*, *Sc. Kozmae* var. *costatus*, *Sc. Kozmae* var. *danubialis*, *Sc. pannonicus* var. *acaudato-granulatus*, *Sc. pannonicus* var. *costato-bicaudatus*, *Sc. producto-capitatus* var. *elegans*, *Sc. pseudoarmatus* var. *danubialis*, *Sc. spinosus* var. *polyspinosus*; *Sc. aculeato-granulatus* f. *heterospinosus*, *Sc. carinatus* var. *bicaudatus* f. *crassicaudatus*, *Sc. columnatus* var. *bicaudatus* f. *danubialis*, *Sc. crassispinosus* f. *granulatus*, *Sc. denticulatus* var. *fenestratus* f. *granulatus*, *Sc. electus* f. *granulatus*, *Sc. ellipsoideus* f. *granulatus*, *Sc. ellipsoideus* var. *symmetro-caudatus* f. *danubialis*, *Sc. intermedius* var. *crassibicaudato-granulatus* f. *longispinosus*, *Sc. Naegeli* var. *acaudatus* f. *heterogranulatus*, *Sc. nanus* f. *granulatus*, *Sc. opoliensis* var. *crassicaudato-granulatus* f. *danubialis*, *Sc. opoliensis* var. *crassicaudato-granulatus* f. *extensus*, *Sc. pécsensis* var. *bicaudato-granulatus* f. *danubialis*, *Sc. pécsensis* f. *hetrocaudatus*, *Sc. similagineus* f. *heterogranulatus*, *Sc. similagineus* f. *simplex*, *Sc. Soói* f. *elegans*, *Sc. Soói* f. *robustum*.

The new taxa were evaluated based on the author's taxonomic concept and criteria, however he knows other opinions published in some recent papers (e.g. HINDÁK 1974, KIRYAKOV 1977, and others).

Diagnoses

1. **Scenedesmus aculeato-granulatus** Hortob. f. **heterospinosus** Hortob. **n. f.** (Fig. 1)

Cellulae 10—12×5—6,3 μm, parum alternatae, membrana granulis bene evolutis coopertae, spinis crassioribus, longioribus, 10,5—11 μm, longis et spinis secundum alterum diagonalem dispositis gracilioribus, brevioribus, similiter mucronatis, 6—7 μm, longis ornatae. Pyrenoidae bene evolutae.

A specie typica spinis longitudine diagonaliter non aequalibus distinctus. V. 1974. — Raro.

2. **Scenedesmus carinatus** (Lemm.) Chod. var. **bicaudatus** Hortob. f. **crassicaudatus** Hortob. **n. f.** (Fig. 2)

Coenobia 4-cellularia, e cellulis non alternatis, 12—13×3—3,7 μm, costis singulis perfectis vel interruptis longitudinalibus, plerumque non rectis, in polis forte 1—2 granulis, spinis singulis 12—13 μm longis, valde crassis, parum undulatis, obtusis, secundum unum diagonalem dispositis, oblique extrorsis ornatis composita.

A var. *bicaudato* Hortob. spinis valde crassis distinctus. VIII. 1971. — Raro.

3. **Scenedesmus carinatus** (Lemm.) Chod. var. **brevicaudatus** Hortob. **n. var.** (Figs 3—6)

Coenobia e cellulis ± alternatis, 9—17×2,6—5,2 μm magnis, forma parum insolitis: in medio convexis, prope spinas parum concavis, vel seriebus singulis longitudinalibus granulorum, vel saepe costis singulis, parum undulatis, non levibus, longitudinalibus ornatis formata. Poli extimarum cellularum spinis singulis obliquis, crassissimis, rectis vel inclinatis, obtusis 2,5—5,5 μm longis, dein dentibus singulis raro 2 parvis, 0,7—1 μm longis ornati.

A specie typica spinis valde brevioribus distinctus. VIII. 1974. — Saepe.

4. **Scenedesmus columnatus** Hortob. var. **bicaudatus** Hortob. f. **danubialis** Hortob. **n. f.** (Fig. 7)

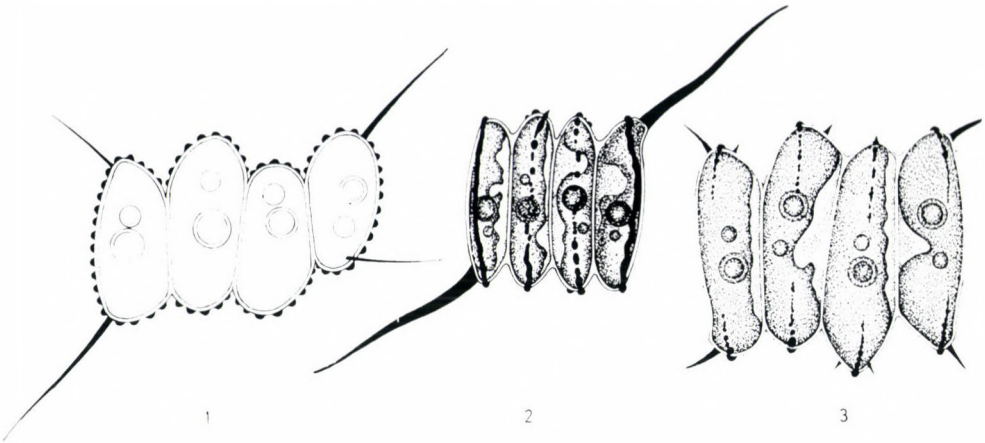
Cellulae coenobiorum 10,4—13×3,8—4,2 μm, parte 2/3—3/4 longitudinis ab invicem conjunctae, polis rotundatis, saepe apicibus obtusae, membrana in medio costa singula, recta, verrucosa, praeter eam striis gracilibus parallelis ornatae. Cellulae extimae secundum unum diagonalem spinis singulis perpendicularibus, parum arcuatis — undulatis, valde crassis, obtusis, 15,6—17 μm, longis, subtus ad basin 1—1,3 μm, crassis, basibus earum crassis, lentiformiter dilatatis, 1,7—2 μm, latis, 0,7—1 μm, altis. Chloroplastus parietalis, pyrenoidis 1—1 bene evolutis.

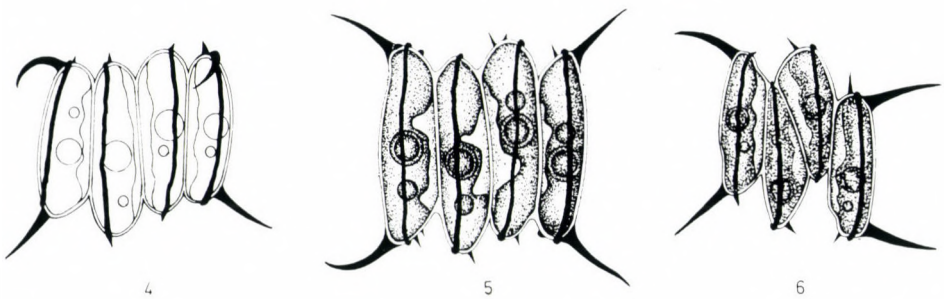
V. 1971. — Raro.

5. **Scenedesmus crassispinosus** Hortob. f. **granulatus** Hortob. **n. f.** (Fig. 8)

Coenobia 4-cellularia, e cellulis alternatis, 15—17×6—6,5 μm magnis, in polis granulis maioribus nonnullis, membrana minute granulata instructis composita. Spinae polorum cellularum extimarum crassae, rectae vel parum inclinatae, obtusae, 7,8—9,2 μm longae. In polis singulis cellularum mediarum spinae singulae baculiformes, alternatae, parum inclinatae, obtusae, 2,6—3,2 μm longae.

A specie granulis membranae distinctus. V. 1972. — Raro.





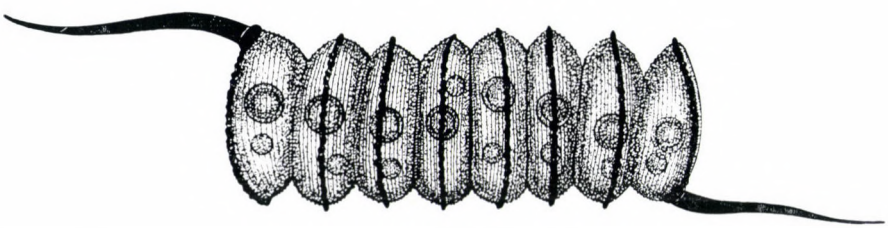
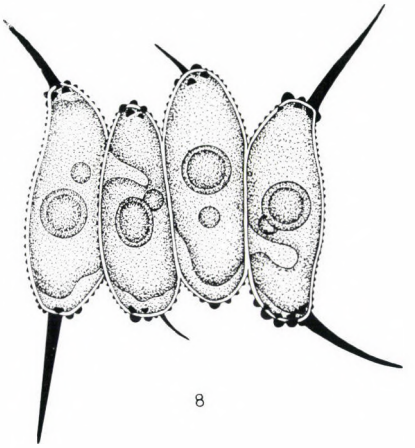


Fig. 1. Scenedesmus aculeato-granulatus Hortob. f. *heterospinosus* Hortob.
Fig. 2. Scenedesmus carinatus (Lemm.) Chod. var. *bicaudatus* Hortob. f. *crassicaudatus* Hortob.
Figs 3—6. Scenedesmus carinatus (Lemm.) Chod. var. *brevicaudatus* Hortob.
Fig. 7. Scenedesmus columnatus Hortob. var. *bicaudatus* Hortob. f. *danubialis* Hortob.



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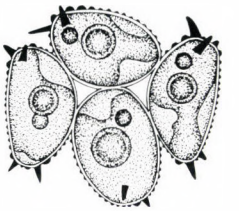

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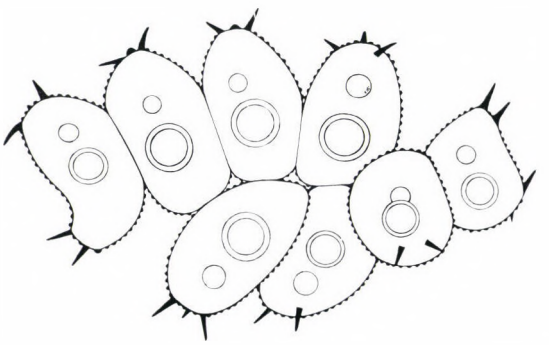

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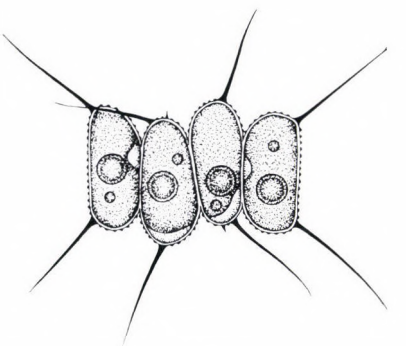

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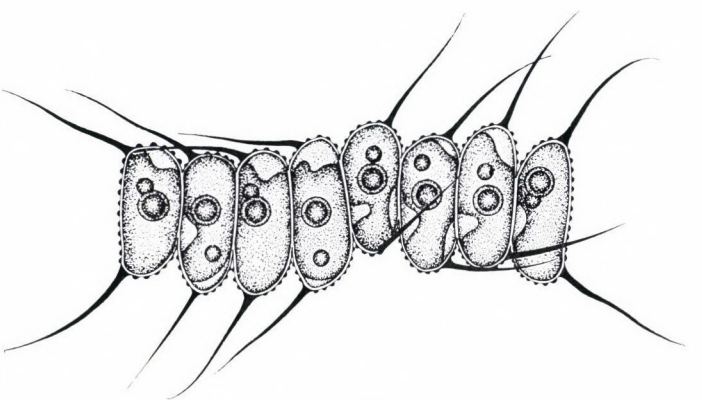

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Fig. 8. Scenedesmus crassispinosus Hortob. f. *granulatus* Hortob.
Figs 9—10. Scenedesmus denticulatus Lagerh. var. *fenestratus* (Teiling) Uherkov. f. *granulatus* Hortob.
Figs 11—12. Scenedesmus electus Hortob. f. *granulatus* Hortob.

6. **Scenedesmus denticulatus** Lagerh. var. **fenestratus** (Teiling) Uherkov. f. **granulatus** Hortob. **n. f.** (Figs 9—10)

Cellulae coenobiorum biseriatae, non in uno plano dispositae, forte inclinatae, 8,2—13×4,5—7 μm inter eas 1—1 hiatus parvus. Spinae in polis cellularum extimarum binae, in polis extrorsis cellularum mediarum similiter binae, rectae vel parum inclinatae, crassae, obtusae, 1—2 μm longae, inter illis saepe spinae singulae minores, vel papillae singulae-binae. Pyrenoidae eximie evolutae. Membrana granulis parvis cooperta.

A var. *fenestrato* (Teiling) Uherkov. membrana granulata et coenobiis arcuatis distinctus. V., VII. 1973. — Raro.

7. **Scenedesmus electus** Hortob. f. **granulatus** Hortob. **n. f.** (Figs 11—12)

Coenobia 4-, vel 8-cellularia, e cellulis 7,8—11×3,8—4,3 μm, forte parum alternatis constructa; in polis cellularum omnium spinis singulis, 9—11,7 μm longis, gracilibus, rectis vel parum inclinatis, mucronatis, in uno dimidio coenobii ad unum laterem versus, in altero ad alterum versus directis, raro praeter spinas longas in cellulis mediis dentibus singulis parvis ornata. Membrana seriebus parvis verrucarum cooperta. Pyrenoidae magnae.

A specie cellulis maioribus, spinis longioribus polorum deinde membrana seriebus verrucarum cooperta distinctus. V. 1972. — Non raro.

8. **Scenedesmus ellipsoideus** Chod. f. **granulatus** Hortob. **n. f.** (Figs 13—15)

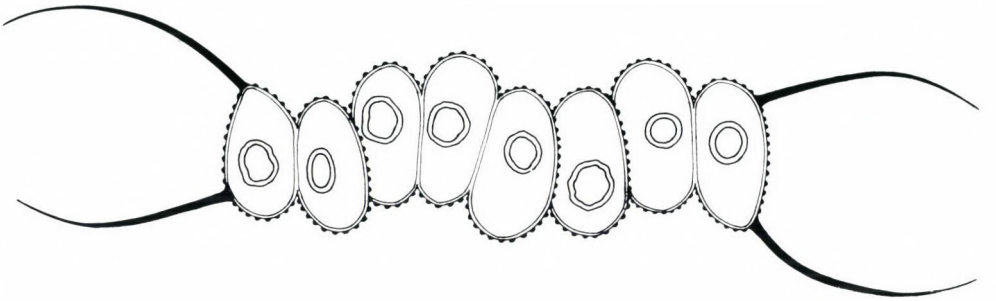
Coenobia forte parum inclinata, tantum 8-cellularia visa, e cellulis binis vel quaternis, 8—13×3,8—7,3 μm magnis, compresse ellipsoidibus — ovalibus constructa. Spinae singulates in polis cellularum extimarum 13—22 μm longae, crassae, inclinatae — undulatae, obtusae, diagonaliter ad modum imaginis in speculo expressae dispositae. Membrana vel granulis parvis vel verrucis maioribus cooperta. In primo casu poli verrucis 1—3 maioribus, in secundo similiter, sed rarius, ornati. Cellulae mediae forte dentibus singularibus brevibus instructae.

A specie praecipue membrana granulata et spinis crassis distinctus. V. 1972., V. 1974. — Raro.

9. **Scenedesmus ellipsoideus** Chod. var. **spinosus** Hortob. **n. var.** (Fig. 16)

Cellulae ellipsoidicae, 6,5—7,8×12—13,7 μm, in polis ipsarum extimarum spinis singulis, caeterarum binis, brevibus, 1—2,3 μ longis in cellulis extimis spinis singulis, diagonaliter dispositis, 18—20 μm longis, valde crassis, inclinatis — undulatis, obtusis ornatae. Membrana levis. In chloroplasto ante divisionem pyrenoida magna unica.

A specie typica spinis in polis cellularum extimarum singulis, sed cellularum mediarum binis brevibus distinctus. V. 1974. — Raro.



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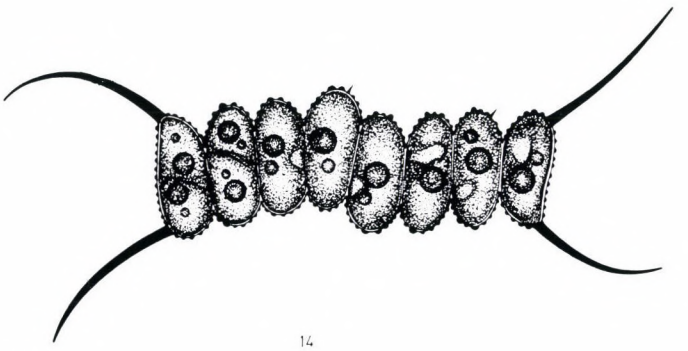

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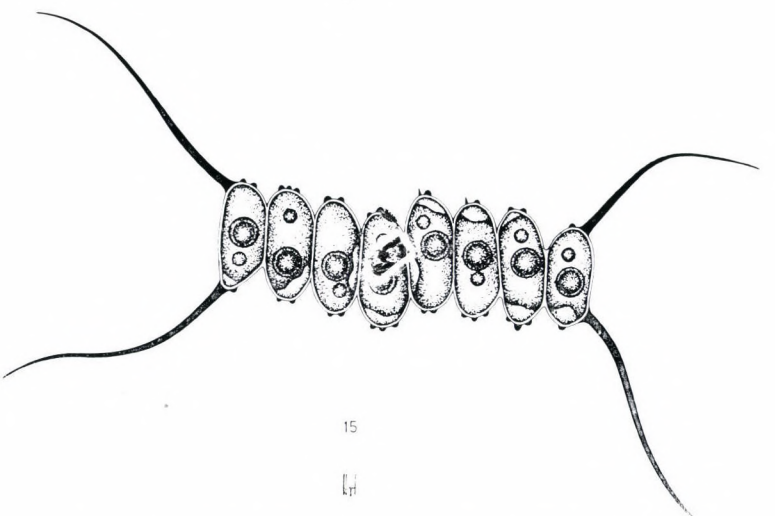

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Figs 13—15. Scenedesmus ellipsoideus Chod. f. *granulatus* Hortob.

10. **Scenedesmus ellipsoideus** Chod. var. **symmetrico-caudatus** Uherkov. f. **danubialis** Hortob. **n. f.**. (Fig. 17)

Coenobia forte parum inclinata, e cellulis forte inclinatis, ellipsoidicis, 9,4—10,5×4,8—5,2 μm magnis, constructa. In polis cellularum extimarum spinae valde crasse, inclinatae, obtusae, 15—17 μm longae, deinde dentes singuli parvi, in polis illis vicinarum spinae singulae, 11—12 μm longae, alternanter dispositae, graciles, rectae vel parum inclinatae, in polis omnium caeterarum dentes bini breves. Chloroplastus cellulam non plane implens, in eo pyrenoida unica magna.

A varietate ab UHERKOVICH descripta distinctus: 1. per exiguitatem cellularum, 2. spinis extimis crassis obtusisve, 3. per formam spinarum cellularum mediarum. V. 1974. — Raro.

11 **Scenedesmus intermedius** Chod. var. **crassibicaudato-granulatus** Hortob. **n. var.** (Fig. 18)

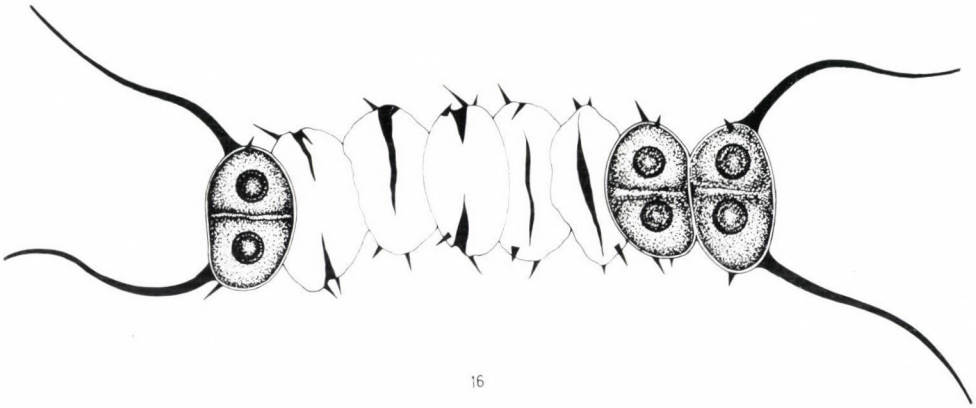
Coenobia e cellulis 11,5—13×4,5—5,3 μm, non in una altitudine dispositis, parte 2/3—3/4 longitudinis sese tangentibus, polis rotundatis, saepe — praesertim in cellulis mediis — polo altero angustioribus. Membrana granulis conspicuis cooperta, in polis verrucis nonnullis eximie magnis. Cellulae extimae secundum unum diagonalem spinis singulis crassissimis, parum inclinatis, oblique extrorsis, obtusis, 9,5—10,5 μm longis, ad basin 1—1,3 μm crassis. Chloroplastus, cellulam, praesertim circa polos conspicue, non implens. Pyrenoidae pro ratione magnae. Coenobia 8-cellularia in duas partes 4-cellulares divisa.

Scenedesmus intermedius Chod. var. *bicaudatus* Hortob. f. *granulatus* Hortob. ei proximus. Ab eo var. nova nostra distinguitur: 1. spinis eximie crassibus obtusisve, 2. membrana circa polos verrucis maioribus, alibi minoribus cooperta. VIII. 1971. — Raro.

12. **Scenedesmus intermedius** Chod. var. **crassibicaudato-granulatus** Hortob. f. **longispinosus** Hortob. **n. f.** (Fig. 19)

Coenobia e cellulis 6,7—8×3—3,4 μm magnis, non in una altitudine dispositis: quasi in coenobiis 2 disposities, i. e. cellulis unius dimidii coenobii in una altitudine, cellulis autem alterius dimidii in alia altitudine dispositis, constructa. Cellulae extimae spinis singulis, secundum unum diagonalem dispositis, ad axem longitudinalem perpendiculariter directis, parum inclinatis, valde crassis, obtusis, 15—16 μ longis, ad basin 1—1,3 μm crassis, deinde seriebus singulis verrucarum maiorum longitudinalibus ornatae. In cellulis mediis series verrucarum a polis exeuntes conspicuae singulae, sed mox interruptae. In polis verrucae maiores nonnullae. Membrana praeter has seriebus verrucarum minorum cooperta.

Var. *crassibicaudato-granulatus* Hortob. propter spinas extimas, crassas, formam coenobiorum et granulas (verrucas) membranae similis, sed forma nostra nova ab eo distincta: 1. cellulis minoribus, 2. spinis extimis valde longioribus, 3. seriebus verrucarum in cellulis extimis perfectis, in mediis imperfectis. V. 1971. — Raro.



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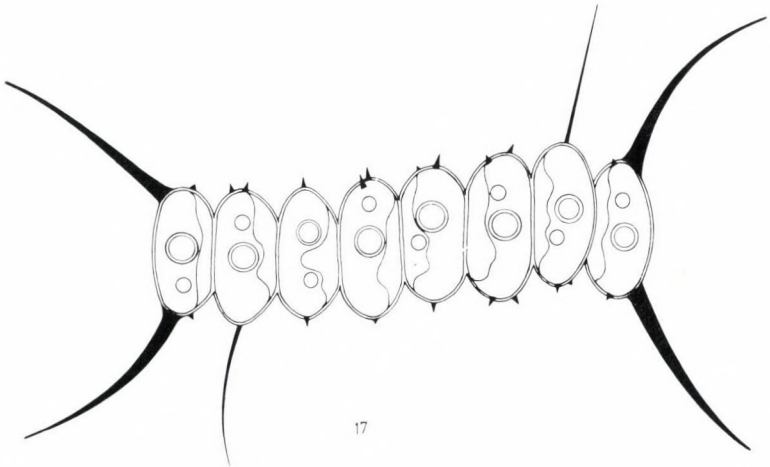

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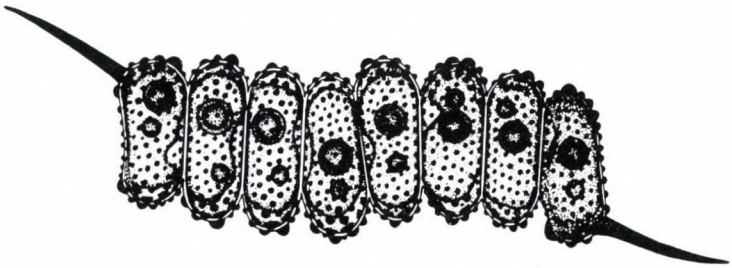

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Fig. 16. Scenedesmus ellipsoideus Chod. var. *spinosus* Hortob.
Fig. 17. Scenedesmus ellipsoideus Chod. var. *symmetro-caudatus* Uherkov. f. *danubialis* Hortob.
Fig. 18. Scenedesmus intermedius Chod. var. *crassibicaudato-granulatus* Hortob.

13. **Scenedesmus intermedius** Chod. var. **geminato-alternans** Hortob. **n. var.** (Fig. 20)

Coenobia e cellulis binis simul alternatis, 7,8—8,6×3—3,6 μm magnis constructa. Cellulae extimae spinis secundum unum diagonalem dispoisitis 5,6—6 μm longis, acutis, rectis, secundum alterum diagonalem 3—3,7 μm longis. Cellulae mediae forte spinis parvis singulis, vel 1—2 verrucis maioribus. Membrana ceterum levis.

Ab omnibus taxonibus *Scenedesmi intermedii* imprimis cellulis geminatim alternatis diversus. V. 1972. — Valde raro.

14. **Scenedesmus intermedius** Chod. var. **spinosiformis** Hortob. **n. var.** (Figs 21—23)

Coenobia e cellulis alternatis, 6,4—7,6×2,8—4 μm magnis, parte 1/3—1/2 longitudinis sese tangentibus constructa. Cellulae extimae in polis spinis singulis, oblique extrorsis, arcuatis vel parum undulatis, gracilibus acutisve, 5—8 μm longis, in lateribus extrorsis spinis 1 vel 2 rectis, vel parum inclinatis, gracilibus, 2,3—4,3 μm longis, deinde in polis prope spinas longas spinis singulis brevibus alternatis ornatae. Cellulae mediae in polis spinis singulis, vel rarius binis, 0,6—2,3 μm longis instructae. Membrana levis.

A taxonibus *Scenedesmi intermedii* parecipue spinis lateralibus cellularum extimarum distinctus. Var. nostra staturam *S. intermedii* cum illa *S. spinosi* Chod. in se ipso coniungens. V. 1972. — Raro.

15. **Scenedesmus Kozmae** Hortob. var. **costatus** Hortob. **n. var.** (Fig. 24)

Coenobia 2-cellularia, e cellulis 13—14,5×4,8—5,3 μm magnis constructa (congruenter cum specie typica ex Vietnam descripta: Hortob., 1966, p. 159—160). Poli cellularum valde rotundati, papillis maioribus, obtusis crassisve versus medium cellularum gradatim minoribus, pileiformiter obtecti. Papillae cellulas usque ad partem 1/5—1/6 longitudinis obtegentes; membrana ceterum levis. Cellulae costis singulis longitudinalibus, rectis, conspicuis. Poli cellularum spinis singulis, parum arcuatis, bene evolutis, 4—5 μm longis, acutis, ad membranam directis vel oblique extrorsis ornati. Chloroplatus parietalis, in eo pyrenoida eximie magna; pyrenoidae speciei typicae similiter eximie magnae.

Var. nova a specie typica distincta: 1. spinis extrorsis longioribus, non obtusis, 2. papillis polorum obtusis pluribus brevioribusque, 3. costis singulis cellularum longitudinalibus, 4. membrana, exceptis polis, levi. VIII. 1971. — Raro.

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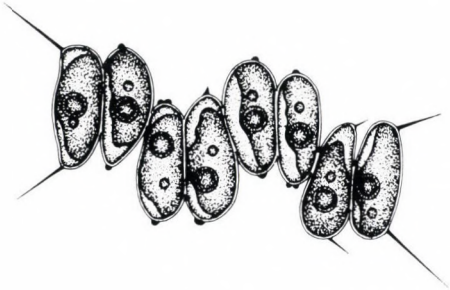

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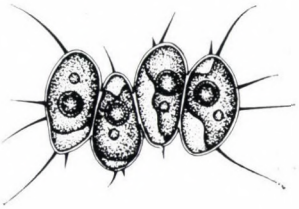

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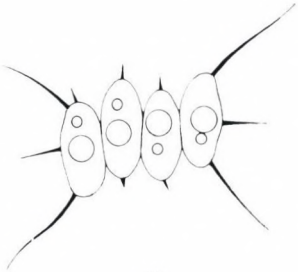

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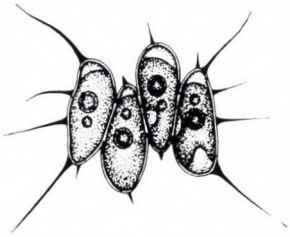

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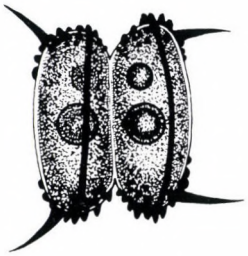

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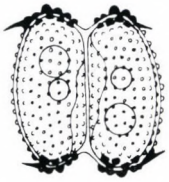

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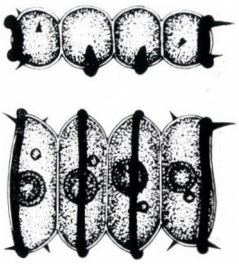

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Fig. 19. Scenedesmus intermedius Chod. var. *crassibicaudato-granulatus* Hortob. f. *longispinosus* Hortob.
Fig. 20. Scenedesmus intermedius Chod. var. *geminato-alternans* Hortob.
Figs 21—23. Scenedesmus intermedius Chod. var. *spinosiformis* Hortob.
Fig. 24. Scenedesmus Kozmae Hortob. var. *costatus* Hortob.
Fig. 25. Scenedesmus Kozmae Hortob. var. *danubialis* Hortob.
Figs 26—27. Scenedesmus Kövesii Hortob.

16. **Scenedesmus Kozmae** Hortob. var. **danubialis** Hortob. **n. var.** (Fig. 25)

Coenobia 2-cellularia, e cellulis 11—12×4,8—5,2 μm spinis extimis acutis, 1—2 μm longis, tenuibus, circa polos verrucis nonnullis eximie magnis, deinde membrana in partibus caeteris papillis minoribus cooperta ornatis constructa.

A specie typica var. nova distincta: 1. spinis extimis brevibus, acutis, brevioribus, 2. polis tantum verrucis ornatis, 3. verrucis (papillis) caeteris membranae aequaliter magnis. A var. *costato* Hortob. distincta: 1. spinis extimis brevibus, 2. verrucis minoribus polorum, 3. membrana ubique granulata, 4. membrana sine costis. VIII. 1971. — Raro.

17. **Scenedesmus Kövesii** Hortob. **n. sp.** (Figs 26—27)

Coenobia e cellulis 9—10,5×3,8—4,3 μm magnis, in una altitudine et in uno plano dispositis constructa. Cellulae extimae in polis spinis singulis, extrorsis, crassis, 1,3—2 μm longis, acutis, in lateribus costis singulis crassis, longitudinalibus, circulariter efformatis, cellulae mediae costis singulis tantum in uno latere efformatis ornatae, praeterea in cellulis omnibus forte dentes parvi singuli.

V. 1972. — Valde raro.

18. **Scenedesmus longistriatus** Hortob. **n. sp.** (Fig. 28)

Coenobia e cellulis alternatis, secundum cellulas scenedesmi acuti efformatis, 15,6—18×4—5 μm magnis, costis gracilibus longitudinalibus ornatis constructa. Cellulae extimae inclinatae, mediae fusoideae, obtusae. Chloroplastus parietalis, cellulam implens vel paene implens, in eo pyrenoida bene evoluta.

Cellulis costis gracilibus ornatis species haec nova ab omnibus taxonibus generis *Scenedesmi* secundum typum "*acutus*" formatis distincta. VIII. 1974. — Valde raro.

19. **Scenedesmus Naegeli** Bréb. var. **acaudatus** Hortob. et Németh f. **heterogranulatus** Hortob. **n. f.** (Figs 29—30)

Coenobia 2- vel 4-cellularia, e cellulis parum alternatis, pyriformibus, 11,5—15,5×4,5—6,5 μm magnis, inclinatis, magna parte longitudinis sese attingentibus constructa. Cellulae in polis granulis 1—2 maioribus, in membrana seriebus granulorum minorum ornatae. Chloroplastus cellulam paene implens. Pyrenoida bene evoluta.

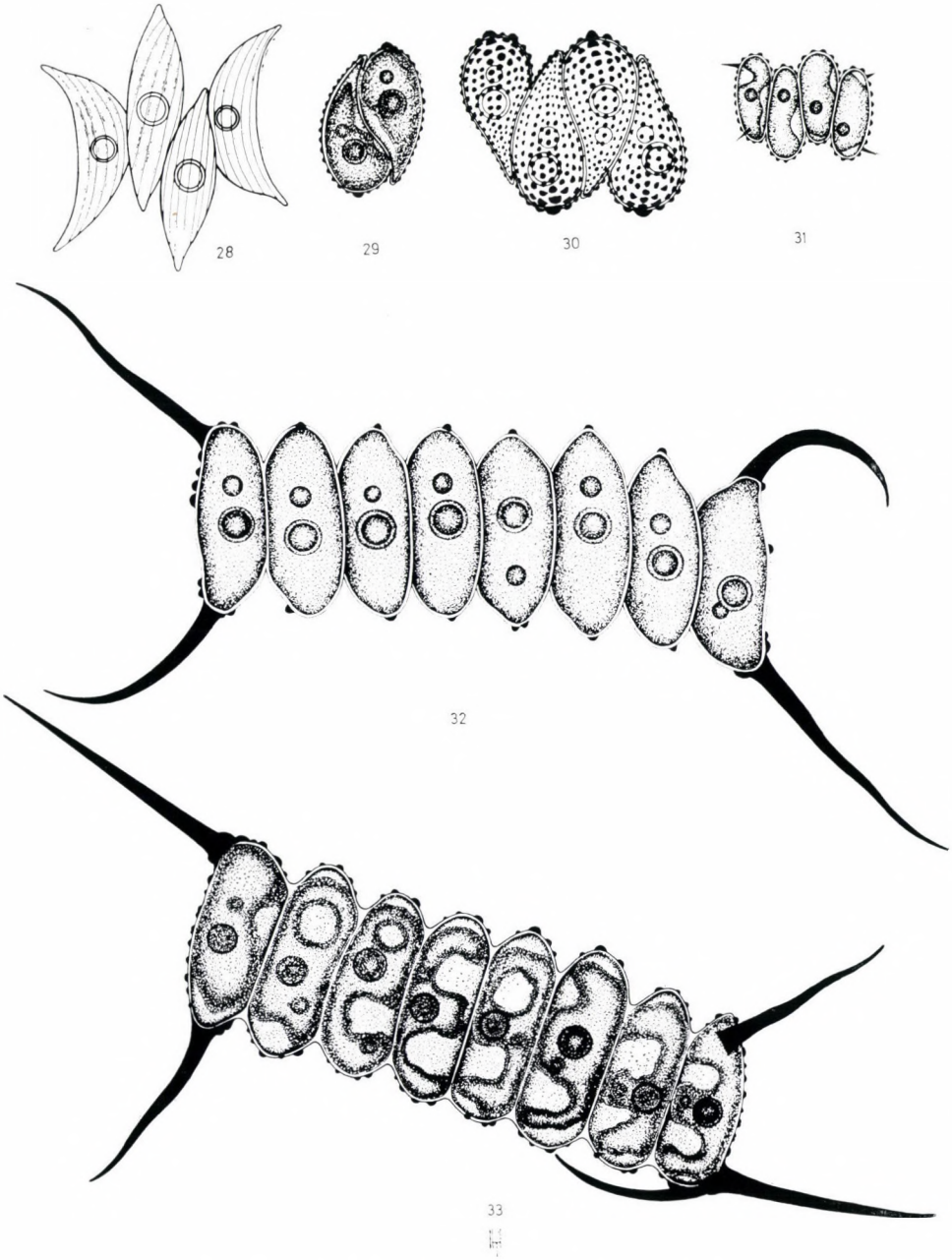


Fig. 28. Scenedesmus longistriatus Hortob.
Figs 29—30. Scenedesmus Naegeli Bréb. var. *acaudatus* Hortob. et Németh f. *heterogranulatus* Hortob.
Fig. 31. Scenedesmus nanus Hortob. f. *granulatus* Hortob.
Figs 32—33. Scenedesmus opoliensis P. Richt. var. *crassicaudato-granulatus* Hortob. f. *danubialis* Hortob.

A var. *acaudato* Hortob. et Németh statura compactiore, granulisve in polis maioribus, in membrana autem minoribus distinctus. VIII. 1971. — Valde raro.

20. **Scenedesmus nanus** Chod. f. **granulatus** Hortob. **n. f.** (Fig. 31)

Cellulae alternatae, 6,5—7,7×2,8—3,2 μm. Membrana seriebus parvis granulorum cooperta. In polis cellularum spinis singulis, 1,2—1,5 μm longis, ad cellulas perpendiculariter directis.

Scenedesmus nanus Chod. f. *maculatus* Hortob. ei proximus, sed ab eo forma nova nostra seriebus parvis granulorum membranae distincta. V. 1972. — Raro.

21. **Scenedesmus opoliensis** P. Richt. var. **crassicaudato-granulatus** Hortob. f. **danubialis** Hortob. **n. f.** (Figs 32—33)

Coenobia vulgo 8-cellularia, ordinarie parum arcuata, e cellulis plerumque non in una altitudine dispositis, 17—20×6,3—7 μm magnis, polis altis, tholiformibus, membranis irregulariter verrucosis—granulatis, vel verrucis maioribus tantum nonnullis inordinate dispositis obtectis, verrucis in polis magis evolutis, densius dispositis constructa. Cellulae extimae spinis crassissimis, obtusis, 18—26 μm longis, ad basin 1,3—2,7 μm latis, rectis vel parum undulatis vel valde curvatis, corniformibus. Spinae extremae proprie diagonaliter secundum directionem aequales. Pyrenoidae bene evolutae, magnae. Fig. 33: specimen in uno polo spinis 2 instructum—abnormitas.

A var. *crassicaudato-granulato* Hortob. distinctus: 1. cellulis maioribus, 2. spinis maioribus et magis evolutis, 3. directione spinarum diagonaliter aequali, 4. membrana non seriebus regularibus verrucarum cooperta, 5. in polis dentibus absentibus. VIII. 1971. — Non raro.

22. **Scenedesmus opoliensis** P. Richt. var. **crassicaudato-granulatus** Hortob. f. **extensus** Hortob. **n. f.** (Fig. 34)

Coenobia 4-, vel 8-cellularia, e cellulis elongatis, non exacte in una altitudine dispositis, forte parum inclinatis, 19,5—22×5,8—6,6 μm magnis, insolite magna parte longitudinis sese attingontibus (quod indolitum in taxis ad typum "opoliensis" pertinentibus) constructa. Cellulae extimae parte minore longitudinis sese attingentes in polis spinis singulis valde crassis, parum inclinatis vel undulatis, obtusis, 15,5—26 μm longis, ad basin 2—2,3 μm latis ornatae. Membrana cellularum verrucosa, in polis papillis 1—2 maioribus.

Var. *danubialis* Hortob. eiusdem speciei ei proximus. Var. nostra ab illo distincta: 1. cellulis maiore parte longitudinis sese attingentibus, 2. cellulis magis elongatis. VIII. 1971. — Non raro.

23. **Scenedesmus pannonicus** Hortob. var. **acaudato-granulatus** Hortob. **n. var.** (Fig. 35)

Coenobia ex cellulis alternatis, non in uno plano dispositis, 17—20,8 × 7,6—8,6 μm magnis constructa, parum inclinata. Membrana cellularum papillis minoribus dense cooperta; circa polos etiam papillis 1—2 maioribus, praeter eas dentes singuli parvi. Pyrenoidae valde evolutae.

In opusculo "On the variability range of *Scenedesmus pannonicus*" (HORTOB., 1966. p. 41—53) 11 taxa ad *Scenedesmus pannonicum* pertinentia explicata. In pag. 47. "Certainly also a 'var. *acaudatus*' unknown so far exists" — haec varietas nova superius descripta: var. *acaudato-granulatus* Hortob n. v.: inter taxis cum membrana granulata instructis taxon unum sine spinis extimis longis, propinquitatem cum taxis spinosis dentibus parvis polorum demonstrans. Spes est varietatem *Scenedesmi pannonici* Hortob. membrana levem, exarmatam invenire.

Varietas nova "*acaudato-granulatus* Hortob." a taxis spinis longis, crassis ornatis spinis absentibus distincta.

HINDÁK (1974, p. 130—139) in opusculo suo de variabilitate morphologica *Scenedesmi pannonici* Hortob. tale taxon non commemorat. VIII. 1971. — Raro.

24. **Scenedesmus pannonicus** Hortob. var. **costato-bicaudatus** Hortob. **n. var.** (Fig. 36)

Coenobia inclinata, e cellulis valde alternatis, 11,5—15 × 5,7—8 μm magnis, secundum unum diagonalem spinis extimis parum inclinatis, crassis, non acutis, 7,5—8 μm longis armatis in lateribus cellularum costis singulis longitudinalibus, verrucosis, bene evolutis ornatis constructa. Membrana — exceptis costis — levis. In polis cellularum extimarum sine spinis longis, spinis singulis alternatis magnitudine similibus.

A var. *bidaudato* Hortob. spinis longioribus costisve crassis et verrucosis distinctus. VIII. 1974. — Raro.

25. **Scenedesmus pécsensis** Uherkov. var. **bicaudato-granulatus** Hortob. f. **danubialis** Hortob. **n. f.** (Fig. 37)

Cellulae non perfecte in una altitudine dispositae, 10—12 × 5—5,5 μm, ovales—ellipticae, parum oblique dispositae, parte 2/3—3/4 longitudinis sese attingentes, spinis secundum unum diagonalem valde crassis, undulatis—arcuatis, non mucronatis, 15,6—17 μm longis, deinde membrana papillis parvis cooperta, et in polis papillis satis maioribus singulis ornatae.

A var. *bicaudato-granulato* Hortob. distinctus: 1. cellulis minoribus (non 15—17,3 × 6—7 μm), 2. spinis crassis longioribus (non 7—8,7 μm longis), arcuatis obtusisque, 3. papillis magnis singulis polorum.

Magnitudine cellularum *Scenedesmo pécsensi* Uherkov. aequalis, sed spinis valde longioribus, crassioribus, obtusis. Cellulae mediae loco spinarum brevium papillis magnis singulis et membrana papillis parvis cooperta instructae (cf. UHERKOVICH 1966, p. 60, Figs 232—236). VII. 1973. — Raro.

26. **Scenedesmus pécsensis** Uherkov. f. **heterocaudatus** Hortob. **n. f.** (Fig. 38)

Cellulae ovales, leves, 14—17×7—11,7 μm, spinis secundum unum diagonalem gracilibus, mucronatis, 6,5—7,2 μm longis, inclinatis, secundum alterum diagonalem spinis 1,3—1,5 μm longis, acutis, parum inclinatis, secundum axem longitudinalem cellularum directis armatae. Chloroplastus cellulam saepe ad dimidium tantum implens. Pyrenoidae globosae vel elongatae.

A specie typica spinis longis secundum unum diagonalem evolutis distinctus. VIII. 1974. — Raro.

27. **Scenedesmus producto-capitatus** Schmula var. **elegans** Hortob. **n. var.** (Fig. 39)

Coenobia parum inclinata, e cellulis non in uno plano dispositis, 10,4—12×2,5—3 μm magnis, in medio valde inflatis, prope polos colliformiter attenuatis, deinde ad instar capitis rursus dilatatis, parte parva longitudinis sese attingentibus, seriebus singulis longitudinalibus verrucarum minorum—maiorum ornatis constructa. Pili depresse convexi, forte parum crassiores, ad margines granulis instructi.

A specie typica seriebus longitudinalibus singulis verrucarum cellularum et polis parum crassioribus distinctus. *Pseudotetradesmus quaternarius* a H. HIROSE et M. AKIYAMA descriptus (1963, pp. 313—316) varietati novae nostrae valde similis quod formam et magnitudinem, sed propagatione diversus. VIII. 1971. — Valde raro.

28. **Scenedesmus pseudoarmatus** Hortob. var. **danubialis** Hortob. **n. var.** (Fig. 40)

Coenobia arcuata, e cellulis 13—14,4×3,8—4,5 μm magnis, costis singulis longitudinalibus, rectis ornatis constructa. Spinae longae polorum cellularum extimarum arcuatae, 12—14 μm longae, parum undulatae, ad basin dilatatae. In polis cellularum extimarum spinae singulae, in illis mediarum spinae binae, rectae, 1,5—3 μm longae.

A specie typica distinctus: 1. costa recta omnium cellularum, 2. spinis cellularum extimarum singulis, mediarum binis, brevibus, 3. cellulis spinisve extimis maioribus, 4. coenobiis parum arcuatis. Var. novae nostrae *Scenedesmus armatus* Chod. var. *boglariensis* Hortob. parallelus. XII. 1971. — Raro.

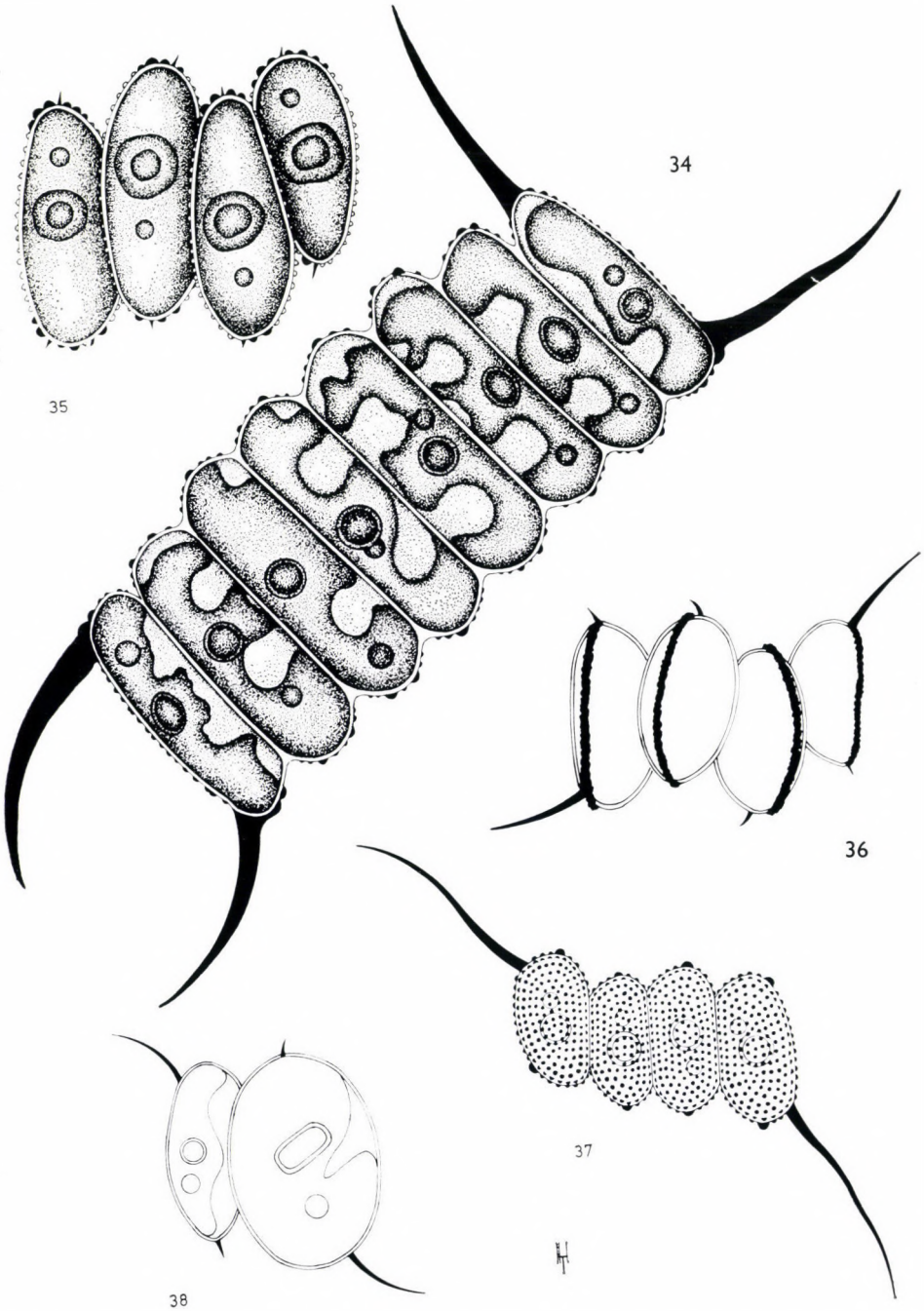


Fig. 34. Scenedesmus opoliensis P. Richt. var. *crassicaudato-granulatus* f. *extensus* Hortob.
Fig. 35. Scenedesmus pannonicus Hortob. var. *acaudato-granulatus* Hortob.
Fig. 36. Scenedesmus pannonicus Hortob. var. *costato-bicaudatus* Hortob.
Fig. 37. Scenedesmus pécsensis Uherkov. var. *bicaudato-granulatus* Hortob. f. *danubialis* Hortob.
Fig. 38. Scenedesmus pécsensis Uherkov. f. *heterocaudatus* Hortob.

29. **Scenedesmus pseudointermedius** Hortob. **n. sp.**
(Figs 41—43)

Coenobia e cellulis non in uno plano dispositis, forte alternatis, parte 1/2—1/3 longitudinis sese attingentibus, 7,2—10×3—4 μm magnis constructa. Poli cellularum extimarum spinisingulis, inclinatis, rarius rectis, 3—10,5 μm longis, ad basin dilatatis, apice saepe non mucros natis. Cellulae mediae verrucis singulis vel spinis parvis singulis: nonnunquam una vel duae cellulae mediae etiam spinis singulis longioribus: raro nonnullae cellularum mediarum leves. Spinae cellularum mediarum 0,5—7,2 μm longae. Membrana levis. Pyrenoidae bene evolutae.

Scenedesmus intermedius Chod. ei proximus. Ab eo spinis ad basin dilatatis distinctus. V. 1972. — Non raro.

30. **Scenedesmus saltator** Hortob. **n. sp.**
(Figs 44—45)

Coenobia 2-cellularia, e cellulis elongate ellipsoidicis, levibus, 9—13×5—6,2 μm magnis, in polis spinis singulis, valde varie curvatis, undulatis-inclinatis, tenuibus, mucronatis, 11—15 μm longis armatis constructa. Spinae in uno polo convergentes, in altero extrorsae. Chloroplastus parietalis, cellulam non perfecte implens, in eo pyrenoida unica, bene evoluta, forma varia.

Directione spinarum singulari ab omnibus taxis generis *Scenedesmi* distinctus. VIII. 1974. — Raro.

31. **Scenedesmus similagineus** Hortob. f. **heterogranulatus** Hortob. **n. f.**
(Fig. 46)

Coenobia valde inclinata, e cellulis 13,3—14,3×5,6—6,5 μm constructa. Membrana seriebus verricarum magnarum cooperta, in polis 2—3 verrucis illis crassioribus. Cellulae latere uno deplanato, altero convexo.

A specie verrucis magnis, secundum magnitudinem in duas partes abeuntibus diversus. VIII. 1974. — Raro.

32. **Scenedesmus similagineus** Hortob. f. **simplex** Hortob. **n. f.**
(Fig. 47)

Coenobia valde inclinata, e cellulis levibus, 12—14×5,6—6,3 μm magnis, proprie similiformibus constructa. Pyrenoidae magnae, forma variae.

A specie typica membrana perfecte levi distinctus. X. 1974. — Raro.

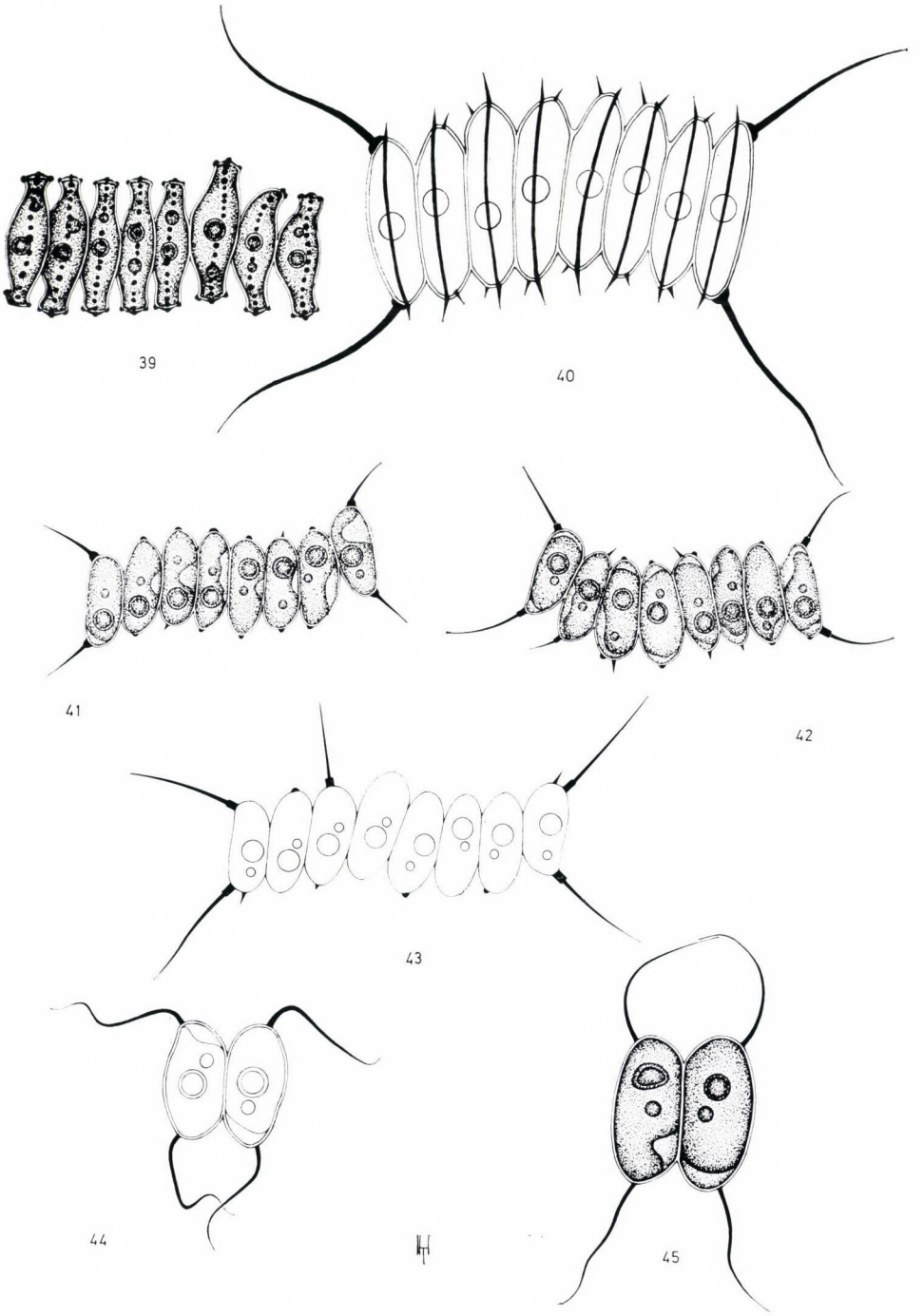
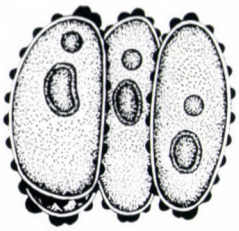


Fig. 39. Scenedesmus producto-capitatus Schmula var. *elegans* Hortob.
Fig. 40. Scenedesmus pseudoarmatus Hortob. var. *danubialis* Hortob.
Figs 41—43. Scenedesmus pseudointermedius Hortob.
Figs 44—45. Scenedesmus saltator Hortob.



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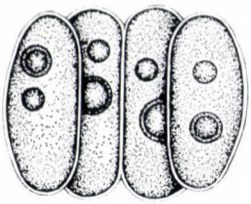

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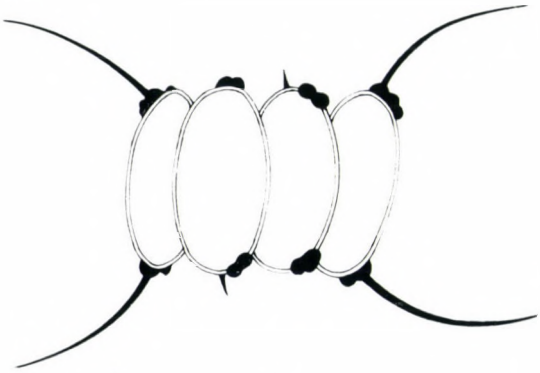

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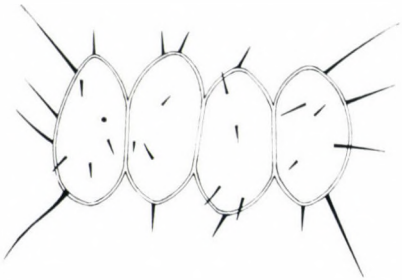

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Fig. 46. Scenedesmus similagineus Hortob. f. *heterogranulatus* Hortob.
Fig. 47. Scenedesmus similagineus Hortob. f. *simplex* Hortob.
Fig. 48. Scenedesmus Soói Hortob. f. *elegans* Hortob.
Fig. 49. Scenedesmus Soói Hortob. f. *robustus* Hortob.
Fig. 50. Scenedesmus spinosus Chod. var. *polyspinosus* Hortob.

33. **Scenedesmus Soói** Hortob. f. **elegans** Hortob. **n. f.**
(Fig. 48)

Cellulae 13—14×5,2—6 μm, spinis 8—9,4 μm longis, basi spinarum columniformi, membrana seriebus singulis bene evolutis verrucarum ornatae.

F. *granulatus* Hortob. et var. *verrucosus* Hortob. eiusdem speciei formae novae proximi. F. nova *elegans* a f. *granulato* distinctus: 1. cellulis majoribus. 2. spinis longioribus, 3. seriebus singulis bene evolutis verrucarum. A var, *verrucoso* membrana levi (excepto seriebus singulis verrucarum) distinguitur. V. 1972. — Raro.

34. **Scenedesmus Soói** Hortob. f. **robustus** Hortob. **n. f.**
(Fig. 49)

Coenobia inclinata, e cellulis ovalibus, 10,5—14×5—6,5 μm constructa. Spinae cellularum extimarum valde arcuatae, bene evolutae, 11—13 μm longae, non mucronatae. Membrana cellularum levis, tantum ad polos 1—2 verrucis valde crassis et ad polos cellularum mediarum spinis parvis alternate dispositis ornata. Bases spinarum extimarum bene evolutae. Chloroplastis parietalis, pyrenoidae bene evolutae.

Scenedesmus Soói Hortob. var. *collaris* (Hortob.) Hortob. ei proximus. Ab eo coenobiis inclinatis, verrucis polorum magnis et spinis brevibus singulis, alternatis cellularum mediarum distinctus. VIII. 1976. — Raro.

35. **Scenedesmus spinosus** Chod. var. **polyspinosus** Hortob. **n. var.**
(Fig. 50)

Cellulae 9,6—10,5×5—5,6 μm magnae. Spinae longae in polis cellularum extimarum 5,4—6,5 μm longae, spinae extrorsae circa medium cellularum extimarum 3—4 μm longae. Spinae caeterae cellularum 1,5—2 μm longae. Membrana levis.

Var. *symmetricus* Hortob. ei proximus. Ab eo var. polyspinosus distinctus: 1. cellulis latioribus, 2. spinis brevibus cellularum inordinate dispositis (cf. HORTOBÁGYI 1960, p. 364, fig. 190—192).

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Acta Botanica Academiae Scientiarum Hungaricae, Tomus 26 (3—4), pp. 339—373 (1980)

MORPHOLOGICAL INVESTIGATION OF RECENT PALMAE POLLEN GRAINS

By

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(Received: 6 January, 1979)

This paper summarizes the results of pollen studies carried out in 100 species of 57 genera. A large part of the species examined was monosulcate, but trichotomosulcate, disulcate and ulcerate types also occurred among them. On the basis of the light microscopical results, types and groups can be separated, which are useful in detecting closer botanical relationships in the fossil forms.

Introduction

Several data are available in the literature on the morphology of *Palmae* pollen grains. ERDTMAN (1952) presented short descriptions of several species; detailed data and documentation are known from PUNT and WESSELS BOER (1966a, b), THANIKAIMONI (1966, 1970) and SOWUNMI (1972). They used extensive material for their examinations. The first electron microscopic results on *Palmae* pollen grains were published by THANIKAIMONI (1970) and HASELDONCKX (1972).

The main aim of our study was to provide data on fossil forms for their more exact determination. In addition to light as well as scanning electronmicroscopic examinations were carried out; which were important with respect of pollen grains that are more or less smooth light-microscopically or the contour is not expressed.

Material and method

Acetolized pollen grains were examined in glycerin-jelly preparations, with oil immersion objective. Photographs of 1000× magn. taken at two depths of pollen grains are presented. Beside the light microscopical data some scanning electronmicroscopic results are also given preliminarily. The investigation material has been obtained from a great number of botany gardens and collections. I should like to express my gratitude here to all who supported my work by sending me pollen materials: BASILEWSKAIA, N. (Bot. Gard., Univ. Moscow), BRUINSMA, B. F. (Botanic Garden of the University, Leiden), Dr. COETZEE, J. A. (Bot. Dept., U.O.F.S., Bloemfontein), VAN DYKE, B. (U.S.A. Shell Dev. Comp.), GILLES, A. (Faculté des Sciences de Lyon), GIUGNOLINI, L. (Inst. Bot. Della Univ. di Firenze), Dr. GRAY, J. (The Univ. of Arizona, Tucson), KLEWENSKAYA, T. (Bot. Gard., Univ. Moscow), Dr. KRAMER, K. U. (Bot. Mus. en Herb. van de Rijks Universiteit), Dr. KRIVÁN-HUTTER, E. (M.Á.F.I., Budapest), Dr. LEOPOLD, E. (U.S. Geological Survey, Geol. Division, Denver, Federal Center, Colorado), Dr. MARÓTI, I. (Dept. of Botany, J. A. University, Szeged), Dr. POTZDAL, E. (Bot. Gart. u. Mus., Berlin Dahlem), SMITH, N. D. (U.S.A. Shell Dev. Comp.), Dr. SOHMA, K. (Tohoku Univ., Biol. Inst., Aoba-Yama, Sendai), Dr. TATE AMES, H. (Pennsylv. State Univ. Coll. of Min. Ind., Pal. Lab., Pennsylvania), Dr. TRAVERSE, A. (U.S.A. Shell Dev. Comp.),

Table 1

Origin of the studied materials

Name of the species	Collector	Habitat	Donator
Areca catechu L.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Pinanga disticha Blume	unknown	Cult. Bot. Gard., Bogor, Java	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Rhopalostylis baueri H. Wendland et Drude	N. BASILEWSKAIA and T. KLEWENSKAYA	Bot. Gard., Univ. Moscow	N. BASILEWSKAIA and T. KLEWENSKAYA
Gaussia princeps H. Wendl.	unknown	Cuba, prov. Pinar del Rio, San Diego de los Baños	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Chamaedorea concolor Mart.	? S. JÁVORKA	Hortus Botanicus, Budapest	J. ÚJHELYI, Botanical Museum
Chamaedorea desmoncoides Wendl.	L. HAYNALD	Hortus Botanicus, Vienna	J. ÚJHELYI, Botanical Museum
Chamaedorea elatior Mart.	L. GIUGNOLINI	Orto Bot. dell'Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Chamaedorea ernesti-angusti H. Wendl.	L. GIUGNOLINI	Orto Bot. dell'Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Chamaedorea fragrans (R. et P.) Mart.	unknown	unknown	J. GRAY, The Univ. of Arizona, Tucson
Chamaedorea oblongata Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Chamaedorea speciosa H. Wendl.	L. GIUGNOLINI	Orto Bot. dell'Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Chrysalidocarpus lutescens H. Wendl.	H. F. SUN 1030	Indonesia	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica
Phloga polystachya Nor.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Roystonea oleracea (Mart.) Cook	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Roystonea regia (H. B. K.) Cook	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Geonoma schottiana Wart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon

Table 1 (continued)

Name of the species	Collector	Habitat	Donator
Iriartea cf. *corneto* (Karst.) H. Wendl.	B. A. KRUKOFF, det. M. BURRET	Brasil Aere Rio Macauhan	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Microkentia gracilis Wendl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Nenga pumila (Mart.) A. Wendl.	unknown, det. H. E. MOORE	Malesia	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Oncosperma filamentosa Bl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Jessenia cf. *batana* (Mart.) Burret	B. A. KRUKOFF, det. M. BURRET	Brasil, Aere Rio Macauhan	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Normanbya merrillii Becc.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Prestoea montana (Gaertn.) Nichols	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Ptychosperma elegans R. Br.	VIVI TÄCKHOLM	Bot. Gard. Fac. Cairo Univ.	VIVI TÄCKHOLM, Bot. Dept. Fac. of Sci., Cairo Univ., Giza
Ptychosperma ledermanniana (Becc.) Moore et Fosb.	unknown	unknown	E. LEOPOLD, U.S. Geological Survey
Borassus flabellifer L.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Latania loddigesii Mart.	M. BRUINSMA	Málaga, cult.	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Hyphaene critina Gaertn.	A. P. D. INEBLEAN	South Coast, South Africa	J. A. COETZEE, Bot. Dept. U.O.F.S.
Hyphaene obconica Damm.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Hyphaena ventricosa Kirk	unknown	unknown	J. GRAY, The Univ. of Arizona, Tucson
Arenga saccharifera Labill.	unknown	unknown	J. A. COETZEE, Bot. Dept. U.O.F.S.
Caryota cummingii Lodd.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Caryota sobolifera Wall.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon

Table 1 (continued)

Name of the species	Collector	Habitat	Donator
Didymosperma porphyrocarpa Wendl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Attalea sp.	unknown	Tobago, British West Broadway	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Maximiliana sp.	B. A. KRUKOFF	Brasil, Amazonas, Mon. Humayta	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Aiphanes caryotaefolia Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Astrocaryum argenteum Hort.	L. GIUGNOLINI	Orto Bot. dell' Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Astrocaryum gynacanthum Mart.	unknown	Brasil, Amazonas, Mon. Humayta	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Astrocaryum mexicanum Liebm.	L. GIUGNOLINI	Orto Bot. dell'Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Astrocaryum murumuru Mart.	unknown	unknown	E. KRIVÁN-HUTTER, M.Á.F.I., Palynological Laboratory
Astrocaryum rostratum Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Bactris minor Jacq.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Arecastrum romanzoffianum Becc.	unknown, det. P. DUSIN	Brasil, Paraná, Jacare	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Butia capitata Becc.	L. GIUGNOLINI	Orto Bot. dell'Univ. di Firenze	L. GIUGNOLINI, Orto Bot. dell'Univ. di Firenze
Cocos nucifera L.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Jubaeopsis caffra Beccari	R. MARLOTH	Mouth of Umtantu River	J. A. COETZEE, Bot. Dept. U.O.F.S.
Elaeis guineensis L.	W. RIEGEL	Fairchild Tropical Garden, Miami, Florida	H. TATE AMES, The Pennsylvania State University
Acoelorraphe wrightii (Griseb. et Wendl.) Britton	A. TRAVERSE	Everglades National Park, Florida	A. TRAVERSE, USA Shell Dev. Comp.

Table 1 (continued)

Name of the species	Collector	Habitat	Donator
Brahea dulcis Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Brahea serrulata R. et Sch.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Chamaerops elegans Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Chamaerops gracilis Lodd.	unknown	unknown	B. F. BRUINSMA, Bot. Gard., Univ. Leiden
Chamaerops humilis L.	unknown	unknown	B. F. BRUINSMA, Bot. Gard., Univ. Leiden
Chamaerops martiana Wallich	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Copernicia alba Morong	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Copernicia cerifera Mart.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Copernicia glabrescens Wendl. et Becc.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Corypha elata Roxb.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Corypha umbraculifera L.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Erythea armata Wats.	unknown	unknown	J. GRAY, The Univ. of Arizona, Tucson
Erythea edulis Wats.	unknown	unknown	E. LEOPOLD, U.S. Geological Survey
Licuala fordiana Becc.	Hainan expedition	Hainan	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica
Livistona chinensis Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Livistona subglobosa Mart.	K. SOHMA	Oosumi, Peninsula southern Kyushu	K. SOHMA, Tohoku Univ. Biol. Inst., Aoba-Yama
Rhapis excelsa (Thunb.) Henry	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Sabal mexicana Mart.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Sabal minor Pers.	A. TRAVERSE	Houston, Texas	A. TRAVERSE, USA Shell Dev. Comp.

Table 1 (continued)

Name of the species	Collector	Habitat	Donator
Sabal palmetto (Walt.) Lodd.	BILTMORE Herb. No 34116	Southport, South Carolina	A. TRAVERSE, USA Shell Dev. Comp.
Serenoa repens (Barth) Small	A. TRAVERSE	Everglades, National Park, Florida	A. TRAVERSE, USA Shell Dev. Comp.
Serenoa serrulata (Michx.) Hook	J. H. SIMPSON	Caxirubas Island, Florida	A. TRAVERSE, USA Shell Dev. Comp.
Trachycarpus excelsa (Thunb.) Wendl.	unknown	unknown	J. GRAY, The Univ. of Arizona, Tucson
Trachycarpus fortunei W. Wendl.	K. SOHMA	Bot. Gard. Tohoku Univ., Sendai	K. SOHMA, Tohoku Univ. Biol. Inst., Aoba-Yama
Washingtonia filifera Wendl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Coccothrinax argentata (Jacq.) Bailey	unknown	unknown	J. GRAY, The Univ. of Arizona, Tucson
Thrinax parviflora Sw.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Ancistrophyllum secundiflorum Wendl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus andamaniacus Kurz.	KIRG	S. Andaman	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Calamus diepenhorstii var. *exulans* Becc.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus guruba Ham.	unknown	unknown	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica
Calamus longisetus Griff.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus palustris Griff.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus rotang L.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus secundiflorus Beanv.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Calamus tetradactylus Hance	S. C. CHEN 8387	Kwantung 1953	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica

Table 1 (continued)

Names of species	Colletor	Habitat	Donator
Calamus thysanolepis Hance	N. K. CHUN 41627	Kwantung 1930	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica
Calamus walkeri Hance	W. T. TSANG 21036	Kwantung 1932	WANG FU-HSIUNG, Inst. Bot. Acad. Sinica
Daemonorops melanochaetes Bl.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Lepidocaryum gracile Burret	unknown, det. BURRET	Brasil, Amazonas, Mon. Sao Paolo de Olivenga	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Mauritia flexuosa L.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Mauritia martiana Sprc.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Metroxylon sagu Rottb.	unknown	Buitenzorg, Java cult.	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit
Nypa fruticans Wurmb.	KARTA, det. BEUMÉE	Java, Bamean	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksherbarium
Phoenix acaulis Roxb.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Phoenix dactylifera L.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Phoenix pusilla Gaertn.	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Phoenix reclinata Jacq.	A. PEGLER	district Ketani	J. A. COETZEE, Bot. Dept. U.O.F.S.
Phoenix robusta Hook	unknown	unknown	I. MARÓTI, Komarov Bot. Inst., Herbarium
Phoenix zeylandica Trim.	A. GILLES	Lyon, Jardin Botanique	A. GILLES, Faculté des Sciences de Lyon
Phytelephas poeppigii Gard.	unknown	cult. Bot. Gard. Bogor, Java	K. U. KRAMER, Bot. Mus. en Herb. van de Rijksuniversiteit

Dr. ÚJHELYI, J. (Botanical Museum, Budapest), Dr. VIVI TÄCKHOLM (Bot. Dept., Fac. of Sci., Cairo Univ., Giza, Cairo), Dr. WANG FU-HSIUNG (Inst. Bot. Academia Sinica, Peking). Special thanks are due to BRUINSMA, B. F., Dr. COETZEE, J. A., Dr. SOHMA, K., Dr. TATE AMES, H. and Dr. WANG FU-HSIUNG for the supplementary report on the origin of the specimens sent to me. The specimens examined and the data on them are contained in Table 1.

In the description of the results we followed the system accepted by THANIKAIMONI (1970). After the name of the species the inventory number of the preparation is given, then the plate number of microphotographs and picture number, finally a short morphological characterization follows. The measurement data are given on the basis of 150—200 specimens.

Results

Arecoideae

Areceae

1. **Areca catechu** L. 161-117-1 (Plate I, 1, 2)

Monosulcate, reticulate pollen grains. The diameter of the lumen of the reticula 1.3—2 μ. The exine is 1.8 μ thick, the infratectum is the thickest among the layers.
Longitudinal axis: 28—35 μ.

2. **Pinanga disticha** Blume 161-169-1 (Plate I, 3, 4)

Monosulcate, reticulate pollen grains. The diameter of the lumen of the reticula varies, the small ones are of 0.5 μ, the big ones are of 1—1.5 μ. The exine is 1—1.5 μ thick. The three layers of the ectexine are of identical thickness.
Longitudinal axis: 28—36 μ.

3. **Rhopalostylis baueri** H. Wendland et Drude 161-17815-1 (Plate I, 5, 6)

Monosulcate pollen grains, the exine tectate perforate, the surface rugulate. The perforations of the tectum lie sparsely. The ornamental elements are 1 μ wide. The exine is 1.5—1.8 μ thick, the infratectum is thicker than the tectum and the nexine. The structure is not recognizable under the light-microscope.
Longitudinal axis: 28—38 μ.

4. **Gaussia princeps** Wendl. 161-71-1 (Plate I, 7, 8)

Monosulcate pollen grains, the exine is tectate, inperforate, the surface is smooth. The exine is 1.5 μ thick, the tectum, infratectum and the nexine are of identical thickness. The structure elements do not separate well, they seem of granular structure.
Longitudinal axis: 24—35 μ.

Chamedoreeae

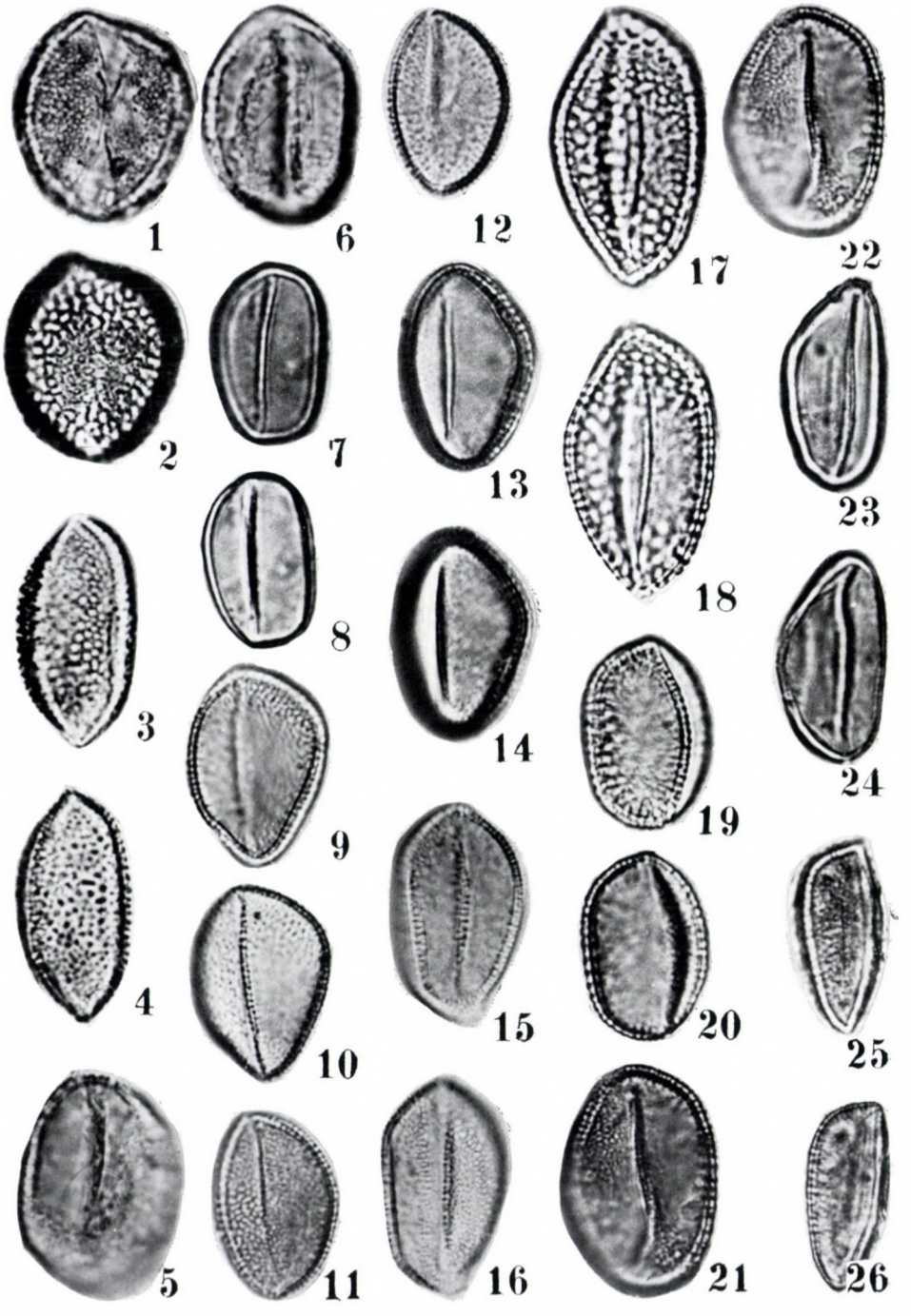
5. **Chamaedorea concolor** Mart. 161-38-1 (Plate I, 9, 10)

Monosulcate, reticulate pollen grains, the lumen of the reticula is maximally 0.5 μ. The width of the muri is 0.2 μ. The exine is 1.5 μ thick, the infratectum is the thickest among the ectexine layers.
Longitudinal axis: 24—30 μ.

→

Plate I

Figs 1, 2. Areca catechu L.
Figs 3, 4. Pinanga disticha Blume
Figs. 5, 6. Rhopalostylis baueri H. Wendland et Drude
Figs 7, 8. Gaussia princeps Wendl.
Figs 9, 10. Chamaedorea concolor Mart.
Figs 11, 12. Chamaedorea desmoncoides Wendl.
Figs 13, 14. Chamaedorea elatior Mart.
Figs 15, 16. Chamaedorea ernesti-angusti H. Wendl.
Figs 17, 18. Chamaedorea fragrans (R. et P.) Mart.
Figs 19, 20. Chamaedorea oblongata Mart.
Figs 21, 22. Chamaedorea speciosa H. Wendl.
Figs 23, 24. Chrysalidocarpus lutescens Wendl.
Figs 25, 26. Phloga polystachya Nor.
Magn.: ×1000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6. **Chamaedorea desmoncoides** Wendl. 161-38-2 (Plate I, 11, 12)
Monosulcate, reticulate pollen grains, the diameter of the lumen of the reticula is greater than 0.5 μ, up to 0.7 μ. The width of the muri is about 2 μ. The thickness of the exine is 1.5 μ, the infratectum is thicker than the tectum and the nexine.
Longitudinal axis: 22—30 μ.

7. **Chamaedorea elatior** Mart. 161-38-3 (Plate I, 13, 14)
Monosulcate, reticulate pollen grains, the lumen diameter of the reticula is in general 1 μ, the breadth of the muri is 0.5 μ. The exine is 1.3 μ thick, the infratectum is thicker than the tectum the nexine.
Longitudinal axis: 26—35 μ.

8. **Chamaedorea ernesti-angusti** H. Wendl. 161-38-5 (Plate I, 15, 16)
Monosulcate, reticulate pollen grains. The diameter of the reticula lumen is up to 0.7 μ. The thickness of the exine is 1.5 μ. Among the layers of the ectexine the infratectum is the thickest.
Longitudinal axis: 24—32 μ.

Clinostigmeae

9. **Chamaedorea fragrans** (R. et P.) Mart. 161-38-6 (Plate I, 17, 18)
Monosulcate, reticulate pollen grains. The diameter of the reticula lumen is 1—2.5 μ. The thickness of the exine is 1—1.5 μ, the tectum, the infratectum and the nexine are of identical thickness.
Longitudinal axis: 35—42 μ.

10. **Chamaedorea oblongata** Mart. 161-38-7 (Plate I, 19, 20)
Monosulcate, reticulate pollen grains. The diameter of the lumen of the reticula 1—2.5 μ, the thickness of the exine 1—2.5 μ. The three layers of the exine are of identical thickness.
Longitudinal axis: 25—30 μ.

11. **Chamaedorea speciosa** H. Wendl. 161-38-9 (Plate I, 21, 22)
Monosulcate, reticulate pollen grains, the diameter of the lumen of the reticula 0.5—0.7 μ. The thickness of the exine 1—1.5 μ the three layers are of the same thickness.
Longitudinal axis: 30—38 μ.

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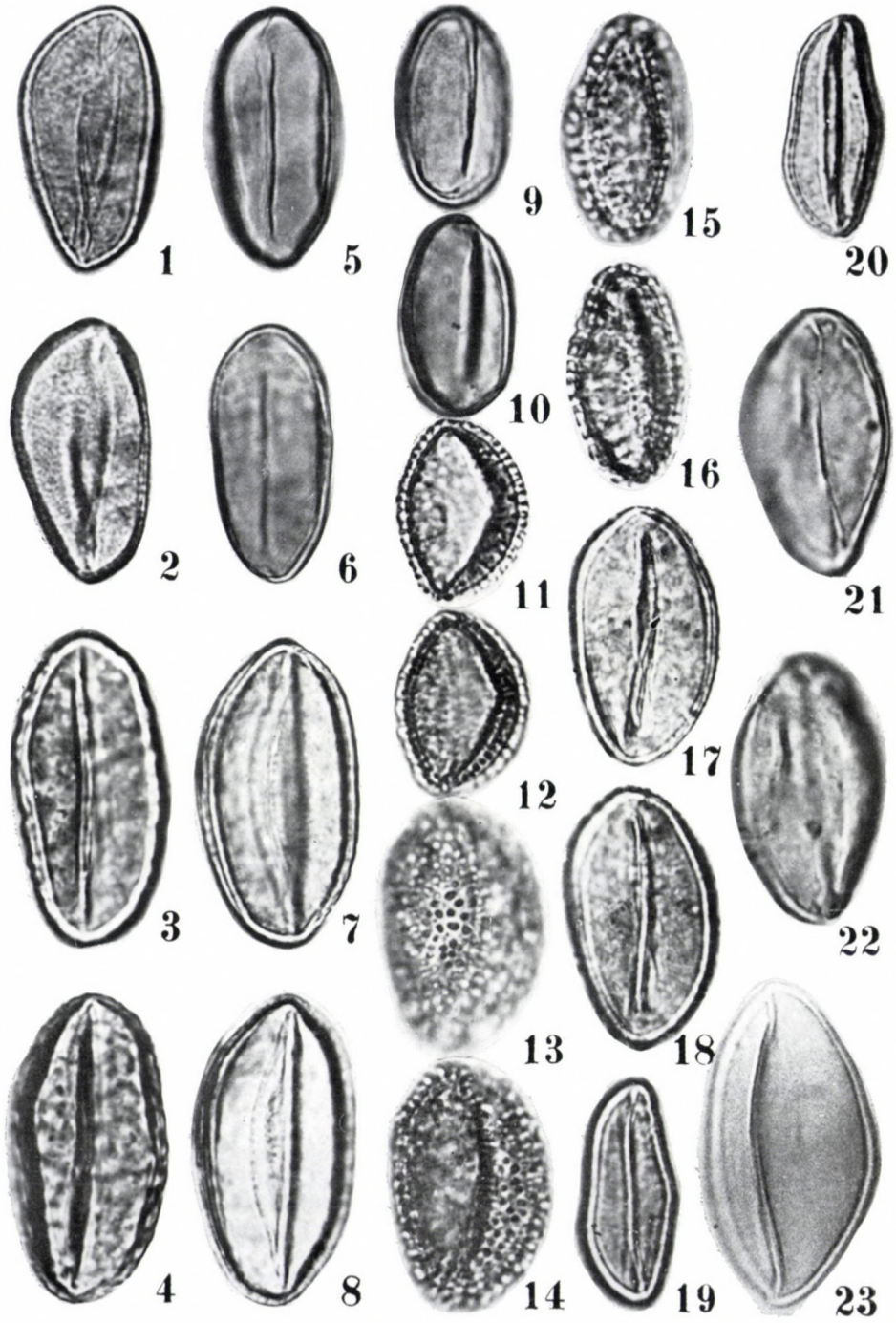
Plate II

Figs 1, 2. Roystonea oleracea (Mart.) Cook
Figs 3, 4. Roystonea regia (H.B.K.) Cook
Figs 5, 6. Geonoma schottiana Wart.
Figs 7, 8. Iriartea cf. *corneto* (Karst.) H. Wendl.
Figs 9, 10. Microkentia gracilis Wendl.
Figs 11, 12. Nenga pumila (Mart.) A. Wendl.
Figs 13, 14. Oncosperma filamentosa Bl.
Figs 15, 16. Jessenia cf. *batana* (Mart.) Burret
Figs 17, 18. Normanbya merrillii Becc.
Figs 19, 20. Prestoea montana (Gaertn.) Nichols
Figs 21, 22. Ptychosperma elegans R. Br.
Fig. 23. Ptychosperma ledermanniana (Becc.) Moore et Fosb.
Magn.: $\times 1000$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12. **Chrysalidocarpus lutescens** H. Wendl. 161-3823-1 (Plate I, 23, 24)

Monosulcate pollen grains, the exine tectate, inperforate, the surface is smooth. The thickness of the exine 1—1.5 μ, the tectum, infratectum and the nexine are of the same thickness. Structure intrabaculate, its elements are well distinguishable.
Longitudinal axis: 28—35 μ.

13. **Phloga polystachya** Nor. 161-168-1 (Plate I, 25, 26)

Monosulcate pollen grains, the exine tectate, perforate, the surface is smooth or finely scabrate. The diameter of the perforations 0.2 μ. The exine is 1—1.3 μ thick. The tectum, infratectum and the nexine are of the same thickness. Structure intrabaculate.
Longitudinal axis: 25—32 μ.

14. **Roystonea oleracea** (Mart.) Cook 161-1715-1 (Plate II, 1, 2)

Monosulcate pollen grains, the exine tectate inperforate, the surface ornamented with flat. elements which are of verrucate/rugulate types. The structure elements are 1—2.5 μ wide. The exine is 1.5—1.8 μ thick, the three layers are identical. The elements of the structure are difficult to be distinguished, probably fine bacula.
Longitudinal axis: 28—38 μ.

15. **Roystonea regia** (H.B.K.) Cook 161-1715-2 (Plate II, 3, 4)

Monosulcate pollen grains, the exine tectate inperforate, the surface rugulate, the ornamental elements are flat, in general 3 μ wide. The exine is 2—2.5 μ thick, the tectum, infratectum and the nexine are of identical thickness. The structure is identical with that of the preceding species.
Longitudinal axis: 40—46 μ.

16. **Geonoma schottiana** Wart. 161-75-1 (Plate II, 5, 6)

Monosulcate pollen grains, the exine tectate, inperforate, the surface smooth. The exine 1 μ thick, the three layers are of the same thickness. The structure elements are of thin column shaped.
Longitudinal axis: 26—36 μ.

Iriarteeae

17. **Iriartea** cf. **corneto** (Karst.) H. Wendl. 161-917-1 (Plate II, 7, 8)

Monosulcate pollen grains, the exine tectate, inperforate. The surface verrucate/rugulate. The measure of the ornamental elements is below 0.5 μ. The exine is in general 2 μ thick, the three layers are of identical thickness. The structure is intrabaculate.
Longitudinal axis: 38—47 μ.

Kentieae

18. **Microkentia gracilis** Wendl. 161-139-1 (Plate II, 9, 10)

Monosulcate pollen grains, exine tectate, inperforate. Surface smooth or finely scabrate. Exine 0.6—0.8 μ thick, tectum, infratectum and nexine of identical thickness. The structure is difficult to be distinguished, constituted of thin columnar elements.
Longitudinal axis: 26—34 μ.

19. **Nenga pumila** (Mart.) A. Wendl. 161-1420-1 (Plate II, 11, 12)

Monosulcate pollen grains, the surface reticulate. The diameter of the lumen of the reticula is 2—3 μ. The thickness of the exine is 2 μ, the sexine is much more thicker than the nexine.
Longitudinal axis: 23—28 μ.

Oncospermeae

20. **Oncosperma filamentosa** Bl. 161-1514-1 (Plate II, 13, 14)

Monosulcate pollen grains, the exine clavate. The diameter of the capituli is 0.5—1.5 μ. Exine thickness 2—2.5 μ, sexine is thicker than the nexine.
Longitudinal axis: 30—38 μ.

Ptychospermeae

21. **Jessenia** cf. **batana** (Mart.) Burret 161-105-1 (Plate II, 15, 16)

The morphological characteristics of the pollen grains are essentially the same as those in the preceding species.
Longitudinal axis: 33—38 μ.

22. **Normanbya merrillii** Becc. 161-1415-1 (Plate II, 17, 18)

Monosulcate pollen grains, surface very finely reticulate. Thickness of exine 1.5—1.8 μ, infratectum is thicker than the tectum and nexine.
Longitudinal axis: 25—40 μ.

23. **Prestoea montana** (Gaertn.) Nichols. 161-1617-1 (Plate II, 19, 20)

Monosulcate pollen grains, surface reticulate. Lumen of reticula 0.4 μ in general, muri breadth 0.2 μ. Exine thickness 1.5—2 μ, the three layers of ectexine are of identical thickness.
Longitudinal axis: 28—36 μ.

24. **Ptychosperma elegans** R. Br. 161-1619-1 (Plate II, 21, 22)

Monosulcate pollen grains, exine tectate inperforate, surface smooth or finely scabrate. Exine 1.5 μ thick, tectum, infratectum and nexine of identical thickness. Structure elements difficult to be distinguished by light microscope, they are probably of granular type.
Longitudinal axis: 32—40 μ.

25. **Ptychosperma ledermanniana** (Becc.) Moore et Fosb. 161-1619-2 (Plate II, 23, Plate III, 1)

Morphological characteristics identical with those of the preceding species.
Longitudinal axis: 43—50 μ.

Borassoideae

Euborasseae

26. **Borassus flabellifer** L. 161-215-1 (Plate III, 2, 3)

Monosulcate pollen grains, exine supratectate, of gemmate ornamentation. Diameter of ornamental elements 1.5—2.5 μ. Tectum inperforate, surface smooth. Thickness of exine 1 μ, tectum, infratectum and nexine of identical thickness. Structure intrabaculate, the elements are well distinguishable.
Longitudinal axis: 43—54 μ.

27. **Latania loddigesii** Mart. 161-121-1 (Plate III, 4, 5)

Monosulcate pollen grains, surface reticulate, lumen of reticula up to 0.5 μ. Exine thickness 0.8—1 μ, tectum, infratectum and nexine of identical thickness.
Longitudinal axis: 23—30 μ.

Hyphaeneae

28. **Hyphaene crinita** Gaertn. 161-823-1 (Plate III, 6, 7)

Monosulcate pollen grains, exine supratectate, of gemmate sculpture. On the basis of size measure, two types of ornamentation can be distinguished. Smaller ones 1.5 μ, greater ones 3—3.5 μ in diameter. The exine is tectate, inperforate, 2 μ thick. The three layers are of equal measure, structure is intrabaculate, its elements are easily distinguishable.
Longitudinal axis: 43—50 μ.

29. **Hyphaene obconica** Damm. 161-823-2 (Plate III, 8, 9)

Exine structure and ornamentation identical with that of H. crinita.
Longitudinal axis: 30—40 μ.

30. **Hyphaene ventricosa** Kirk 161-823-3 (Plate III, 10, 11)

Only its measure is different from the preceding; 58—65 μ.

Caryotideae

31. **Arenga saccharifera** Labill. 161-1175-1 (Plate III, 16, Plate IV, 1)

Monosulcate pollen grains, supratectate echinate ornamentation. The ornamental elements are 4—5 μ long and protruding on their base. Tectum inperforate, surface smooth. Exine 0.8—1 μ thick. Tectum, infratectum and nexine are by and large of equal thickness. The exact structure of infratectum cannot be distinguished by light microscope, it seems of granular structure.
Longitudinal axis: 40—48 μ.

32. **Caryota cumingii** Lodd. 161-3117-1 (Plate III, 12, 13)

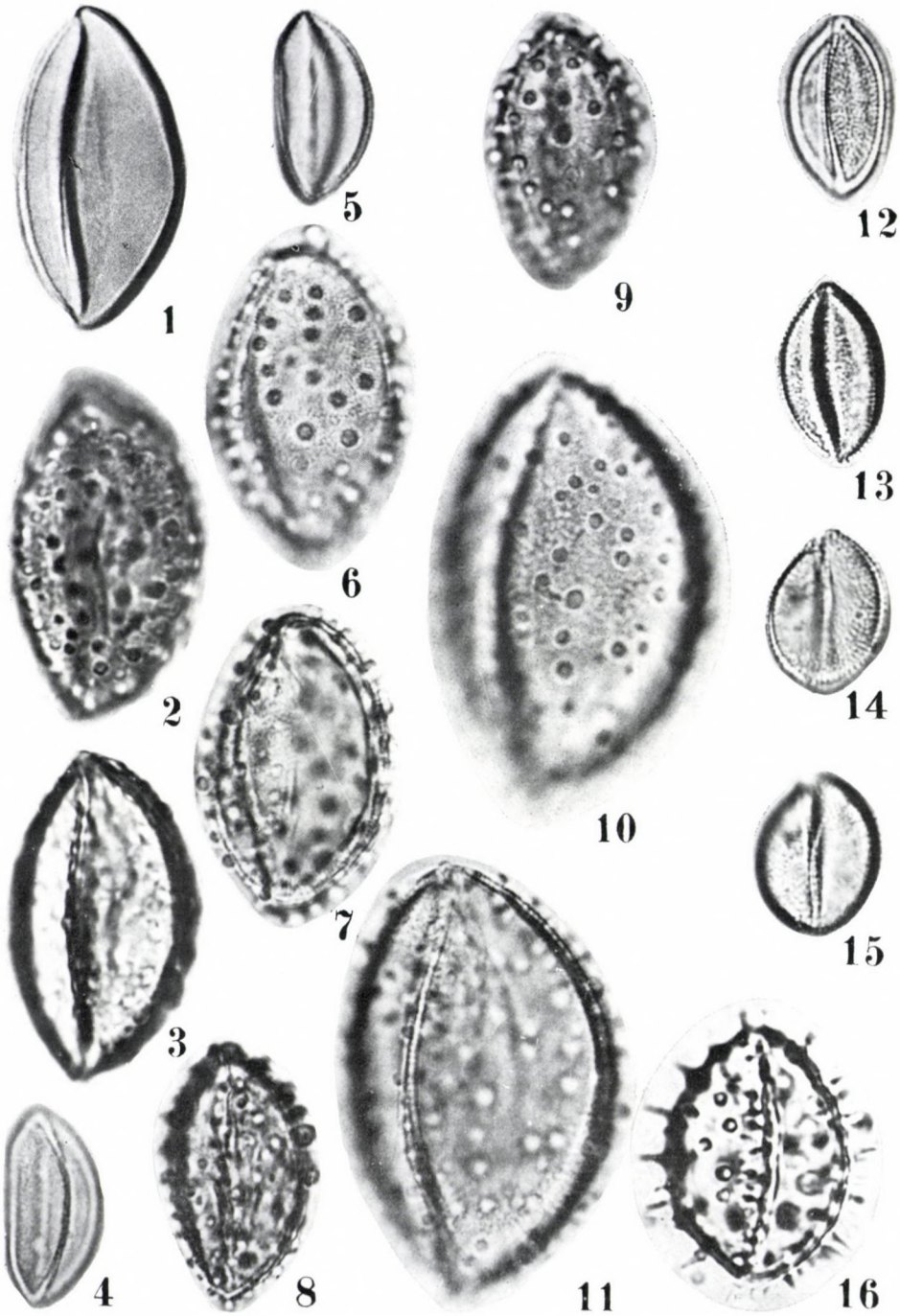
Monosulcate pollen grains, essentially with baculate ornamentation. The ornamental elements rarely are thickened at their ends, but it has no typical clavate sculpture. The exine is 1.2 μ thick, the nexine is thinner than the length of the sculpture elements.
Longitudinal axis: 24—28 μ.

33. **Caryota sobolifera** Wall. 161-3117-3 (Plate III, 14, 15)

The morphological characteristics of the pollen grains are identical with those of the preceding species.
Longitudinal axis: 19—25 μ.

Plate III

Fig. 1. Ptychosperma ledermanniana (Becc.) Moore et Fosb.
Figs 2, 3. Borassus flabellifer L.
Figs 4, 5. Latania loddigesii Mart.
Figs 6, 7. Hyphaene crinita Gaertn.
Figs 8, 9. Hyphaene obconica Damm.
Figs 10, 11. Hyphaene ventricosa Kirk
Figs 12, 13. Caryota cumingii Lodd.
Figs 14, 15. Caryota sobolifera Wall.
Fig. 16. Arenga saccharifera Labill.
Magn.: $\times 1000$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34. **Didymosperma porphyrocarpa** Wendl. 161-49-1 (Plate IV, 2, 3)

Monosculcate pollen grains, the exine is supratectate, echinate. The ornamental elements are 1—2 μ long, the surface is smooth. The exine is 0.6—0.8 μ thick, the structure cannot be distinguished by light microscope.
Longitudinal axis: 18—25 μ.

Cocoideae

Attaleeae

35. **Attalea** sp. 161-119-1 (Plate IV, 4, 5)

Monosulcate pollen grains, exine tectate inperforate, surface smooth. Exine 2.5 μ thick, tectum and nexine of the same measure, infratectum slightly thinner than the preceding layer. Structure is finely intrabaculate.
Longitudinal axis: 48—54 μ.

36. **Maximiliana** sp. 161-1322-1 (Plate IV, 6, 7)

Monosulcate pollen grains, surface reticulate, ornamentation is very fine, lumen diameter up to 0.5 μ. Exine 1.5—2 μ, tectum, infratectum and nexine of identical thickness.
Longitudinal axis: 50—57 μ.

Bactrideae

37. **Aiphanes caryotaefolia** Mart. 161-19-1 (Plate IV, 8, 9)

Monosulcate pollen grains, surface reticulate, lumen diameter up to 0.5 μ, ornamentation is very fine. Exine is 1 μ thick, three ectexine layers of identical thickness.
Longitudinal axis: 22—28 μ.

38. **Astrocaryum argenteum** Hort. 161-118-1 (Plate IV, 10—13)

Monosulcate, sometimes trichotomosulcate pollen grains, surface reticulate, reticulum lumen maximally 0.5 μ. Exine thickness 0.8—1 μ, three ectexine layers of equal thickness.
Longitudinal axis: 35—45 μ.

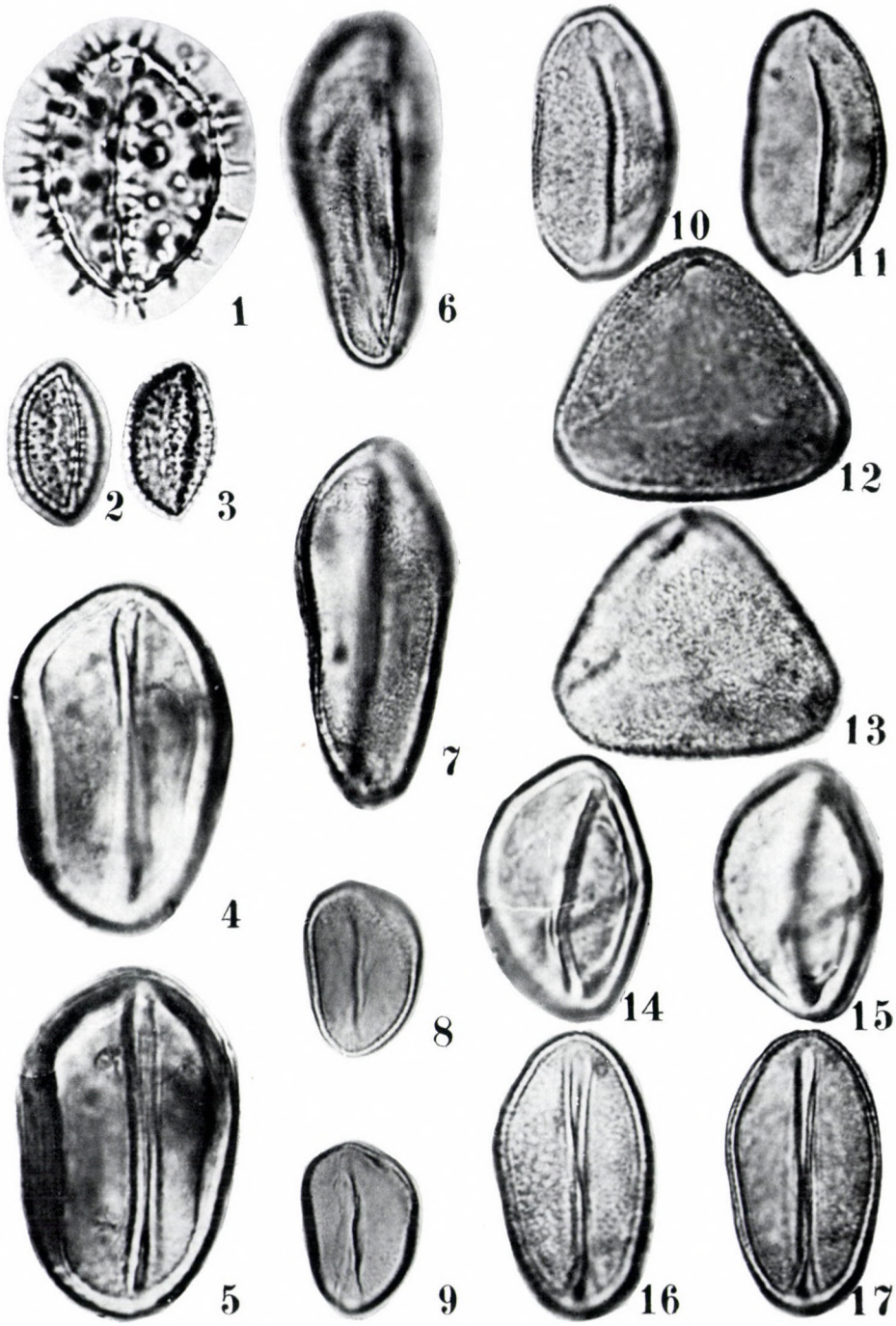
39. **Astrocaryum gynacanthum** Mart. 161-118-2 (Plate IV, 14, 15)

Monosulcate pollen grains, very fine reticulate ornamentation. Exine 1.6—2 μ thick, of the three layers of ectexine tectum is the thickest.
Longitudinal axis: 30—38 μ.

→

Plate IV

Fig. 1. Arenga saccharifera Labill.
Figs 2, 3. Didymosperma porphyrocarpa Wendl.
Figs 4, 5. Attalea sp.
Figs 6, 7. Maximiliana sp.
Figs 8, 9. Aiphanes caryotaefolia Mart.
Figs 10—13. Astrocaryum argenteum Hort.
Figs 14, 15. Astrocaryum gynacanthum Mart.
Figs 16, 17. Astrocaryum mexicanum Liebm.
Magn.: $\times 1000$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40. **Astrocaryum mexicanum** Liebm. 161-118-3 (Plate IV, 16, 17, Plate V, 1, 2)

Monosulcate pollen grains, rarely with trichotomosulcate forms. Surface reticulate, reticulum lumen maximally 0.5 μ. Exine thickness around 0.9 μ, the three exine layers of equal thickness.
Longitudinal axis: 36—48 μ.

41. **Astrocaryum murumuru** Mart. 161-118-4 (Plate V, 3, 4)

Trichotomosulcate pollen grains, exine tectate perforate, occasionally reticulate, reticulum lumen diameter 0.8 μ. Exine 2.5—3 μ thick, infratectum is the thickest of the exine layers. Diameter 65—80 μ.

42. **Astrocaryum rostratum** Mart. 161-118-5 (Plate V, 5, 6)

Monosulcate pollen grains, sometimes with trichotomosulcate forms, surface reticulate, reticulum lumen maximally 0.5 μ. Exine thickness 0.8—1 μ, the three ectexine layers are of identical thickness.
Longitudinal axis: 35—40 μ.

43. **Bactris minor** Jacq. 161-21-1 (Plate V, 7, 8)

Trichotomosulcate pollen grains, tectate perforate exine. Perforation diameter very small, surface otherwise smooth. Exine thickness in general 1 μ, the three layers are of identical thickness. Structure intrabaculate.
Longitudinal axis: 50—60 μ.

Cocoseae and *Elaeideae*

44. **Arecastrum romanzoffianum** Becc. 161-1175-1 (Plate V, 9, 10)

Monosulcate pollen grains, tectate perforate exine, perforations are very sparse. Ornamentation rugulate, the patterns are in general 2 μ wide. Exine 1.5—2 μ thick, tectum, infratectum and nexine are of identical measure. Structure intrabaculate.
Longitudinal axis: 30—36 μ.

45. **Butia capitata** Becc. 161-220-1 (Plate VI, 1, 2)

Monosulcate pollen grains, exine tectate, inperforate. Surface smooth. Exine thickness 1.5 μ, tectum, infratectum and nexine are of identical thickness. Structure intrabaculate.
Longitudinal axis: 36—42 μ.

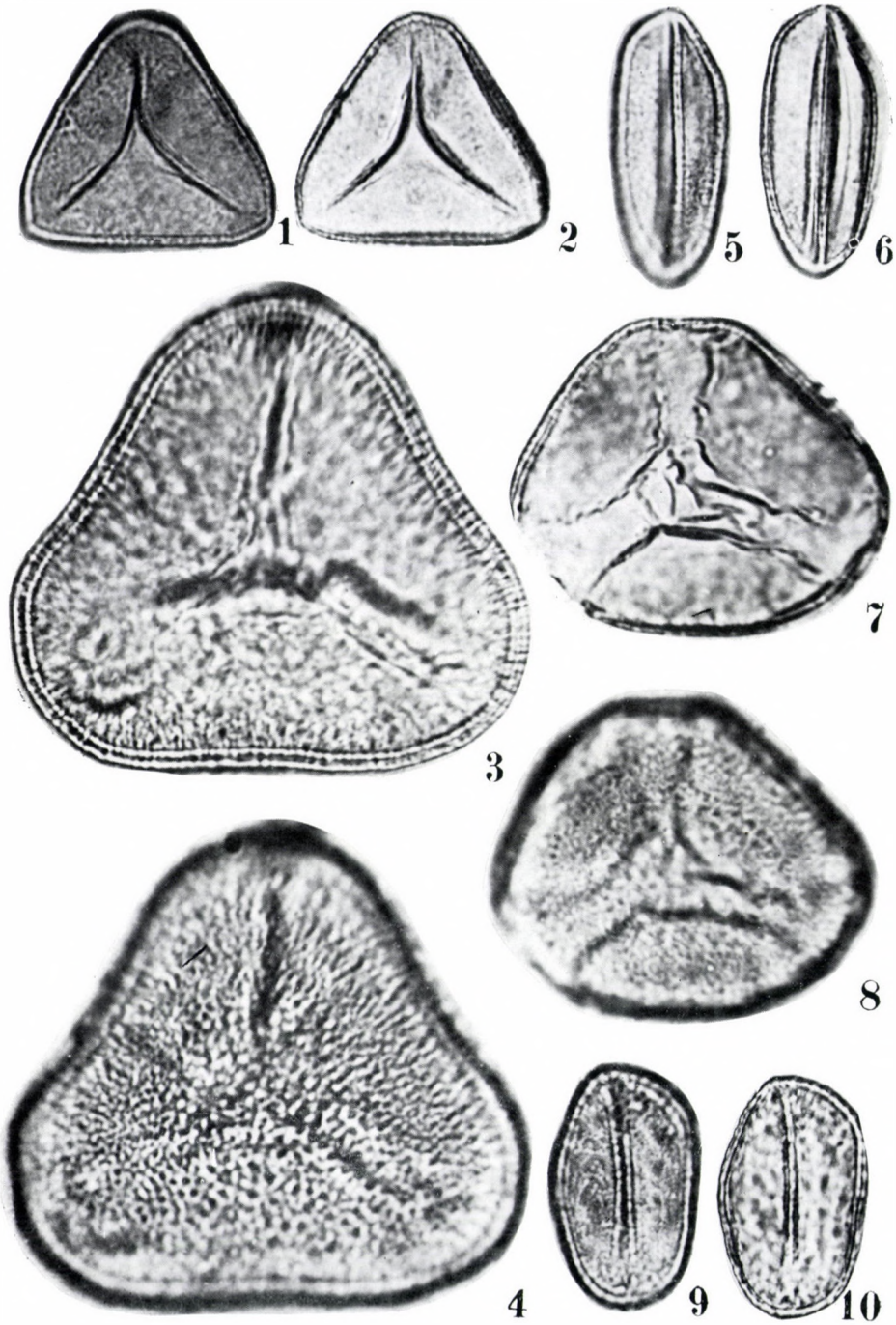
46. **Cocos nucifera** L. 161-3153-1 (Plate VI, 3, 4)

Monosulcate pollen grains, exine tectate perforate, perforations sparsed and small. Surface scabrate. Exine 2—2.5 μ thick, nexine thinner than sexine. Structure is difficult to be distinguished by light microscope, it is probably intrabaculate.
Longitudinal axis: 45—52 μ.

——————→

Plate V

Figs 1, 2. Astrocaryum mexicanum Liebm.
Figs 3, 4. Astrocaryum murumuru Mart.
Figs 5, 6. Astrocaryum rostratum Mart.
Figs 7, 8. Bactris minor Jacq.
Figs 9, 10. Arecastrum romanzoffianum Becc.
Magn.: $\times 1000$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47. **Jubaeopsis caffra** Beccari 161-1020-1 (Plate VI, 5, 6)

Monosulcate pollen grains, exine tectate inperforate, surface granulate, ornamentation pattern diameter 0.2—0.3 μ. Exine 3.5—4 μ thick. Tectum, infratectum is of identical thickness, nexine is thinner than the two preceding layers. Structure intrabaculate.
Longitudinal axis: 58—76 μ.

48. **Elaeis guineensis** L. 161-512-1 (Plate VI, 7, 8)

Trichotomosulcate pollen grains, exine tectate inperforate. Surface very finely punctate. Exine 1.5 μ thick, tectum, infratectum and nexine are of identical thickness. The morphology of the structure elements cannot be distinguished by the light microscope.
Longitudinal axis: 35—42 μ.

Coryphoideae

49. **Acoelorraphe wrightii** (Griseb. et Wendl.) Britton 161-13-1 (Plate VI, 9, 10)

Monosulcate pollen grains, exine tectate perforate, surface smooth or scabrate. Perforation diameter 0.2 μ, lying sporadically. Exine in general 2 μ thick, tectum is thinner than infratectum and nexine. Structure is intrabaculate.
Longitudinal axis: 43—52 μ.

50. **Brahea dulcis** Mart. 161-217-1 (Plate VI, 11, 12)

Monosulcate pollen grains, exine reticulate, reticulum lumen up to 0.5 μ. Exine thickness 1 μ in general. Tectum, infratectum and nexine are of identical thickness.
Longitudinal axis: 23—30 μ.

51. **Brahea serrulata** R. et Sch. 161-217-2 (Plate VII, 1, 2)

Monosulcate pollen grains, exine tectate, perforate, surface smooth or finely scabrate. Tectum perforations small, exine 1—1.5 μ thick, tectum, infratectum and nexine of identical thickness. Structure intrabaculate.
Longitudinal axis: 25—35 μ.

52. **Chamaerops elegans** Mart. 161-3817-1 (Plate VII, 3, 4)

Monosulcate pollen grains, surface reticulate, reticulum lumen up to 0.5 μ. Muri 0.3 μ wide. Exine 0.5 μ thick, the three layers are of identical measure.
Longitudinal axis: 10—16 μ.

53. **Chamaerops gracilis** Lodd. 161-3817-3 (Plate VII, 5, 6)

Monosulcate pollen grains, surface reticulate, reticulum diameter 0.3—0.4 μ, muri width 0.2 μ. Exine thickness 1.5 μ, infratectum slightly thicker than the outer and inner layers.
Longitudinal axis: 24—28 μ.

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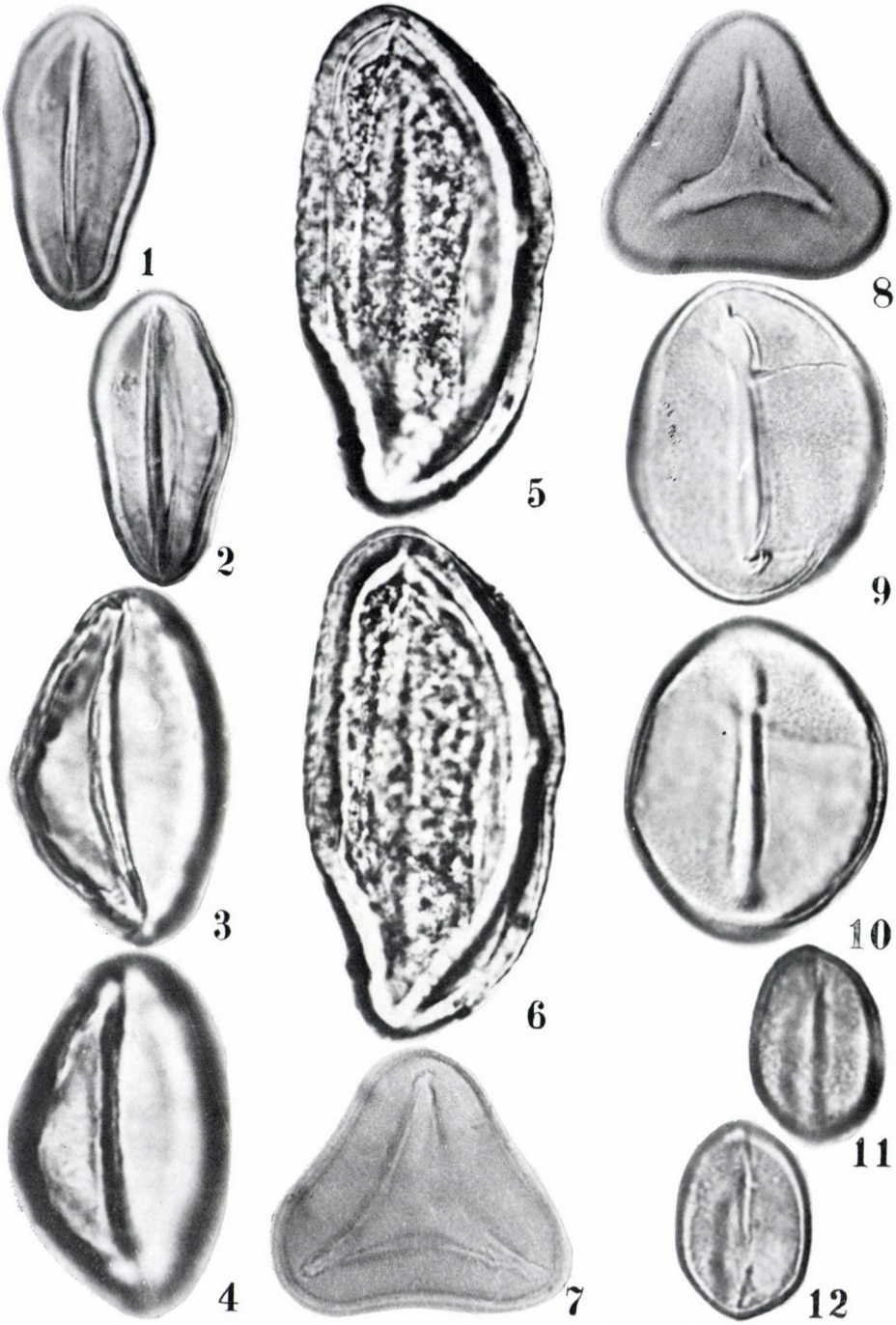
Plate VI

Figs 1, 2. Butia capitata Becc.
Figs 3, 4. Cocos nucifera L.
Figs 5, 6. Jubaeopsis caffra Beccari
Figs 7, 8. Elaeis guineensis L.
Figs 9, 10. Acoelorraphe wrightii (Griseb. et Wendl.) Britton
Figs 11, 12. Brahea dulcis Mart.
Magn.: ×1000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54. **Chamaerops humilis** L. 161-3817-4 (Plate VII, 7, 8)

Monosulcate pollen grains, surface reticulate, reticulum lumen diameter is slightly below 0.5 μ, muri width 0.3 μ. Exine thickness 1.6—1.8 μ, infratectum thicker than the other two ectexine layers.
Longitudinal axis: 26—32 μ.

55. **Chamaerops martiana** Wallich 161-3817-7 (Plate VII, 9, 10)

Morphological characteristics of the pollen are identical with those of the preceding species.
Longitudinal axis: 24—33 μ.

56. **Copernicia alba** Morong 161-31516-1 (Plate VII, 11, 12)

Monosulcate pollen grains, exine reticulate. Reticulum lumen diameter 0.2—0.3 μ, muri width 0.1—0.2 μ. Exine thickness 1.5 μ, ectexine three layers are of identical thickness.
Longitudinal axis: 28—35 μ.

57. **Copernicia cerifera** Mart. 161-31516-2 (Plate VII, 13, 14)

Exine ornamentation is identical with that of the preceding species. Exine thickness in general 1 μ.
Longitudinal axis: 25—32 μ.

58. **Copernicia glabrescens** Wendl. et Becc. 161-31516-3 (Plate VII, 15, 16)

Reticulate ornamentation is finer than that of the preceding species. Exine thickness is 1 μ in general, the three layers of the ectexine are of identical thickness.
Longitudinal axis: 26—32 μ.

59. **Corypha elata** Roxb. 161-31517-1 (Plate VII, 17, 18)

Monosulcate pollen grains, exine reticulate, reticulum lumen diameter up to 0.5 μ. Exine 1.5—2 μ thick, the three layers are of identical thickness.
Longitudinal axis: 28—36 μ.

60. **Corypha umbraculifera** L. 161-31517-3 (Plate VII, 19, 20)

Morphological characteristics of pollen grains are by and large identical with those of the preceding species, only the reticulum lumen diameter is slightly smaller.
Longitudinal axis: 24—30 μ.

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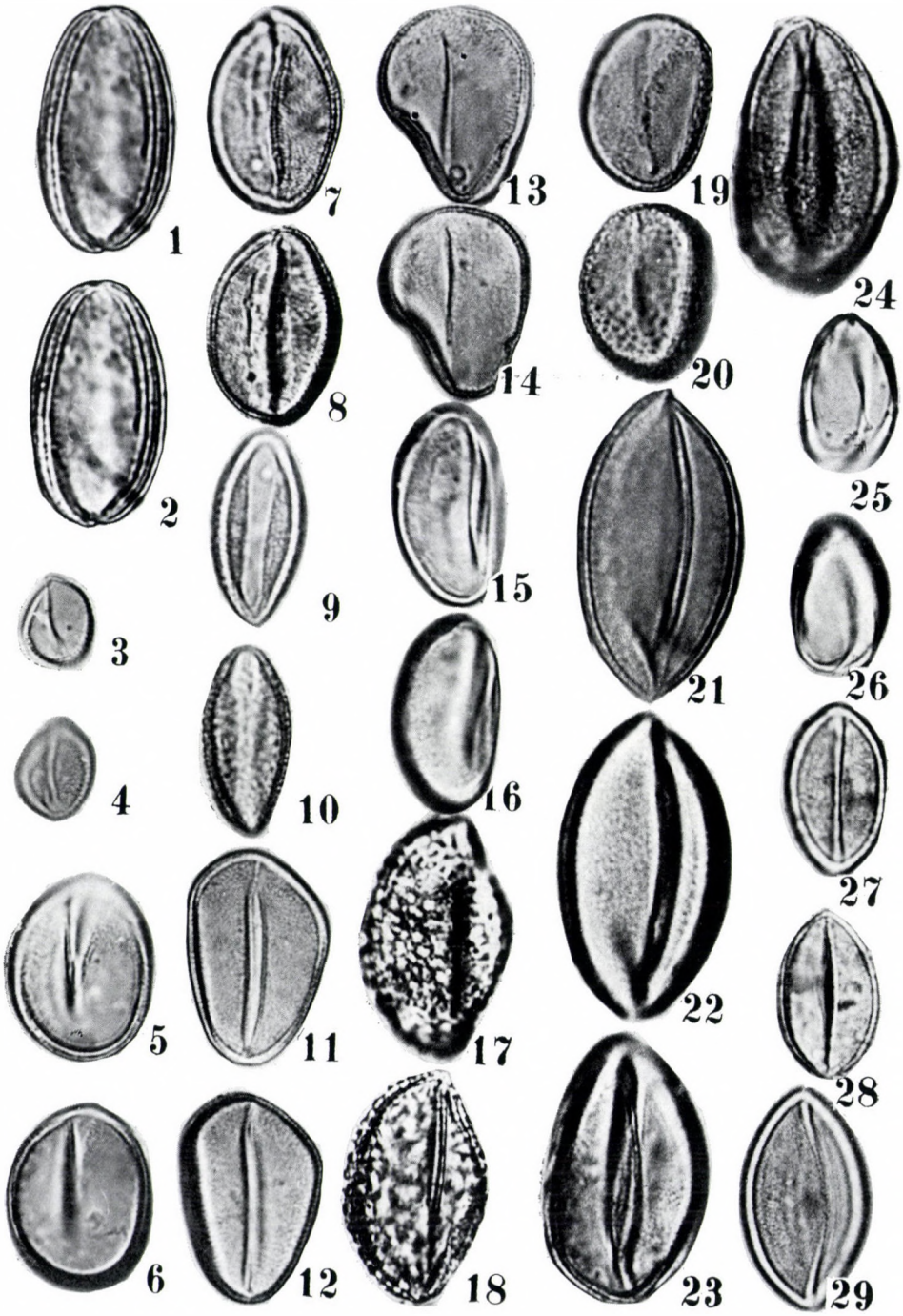
Plate VII

Figs 1, 2. Brahea serrulata R. et Sch.
Figs 3, 4. Chamaerops elegans Mart.
Figs 5, 6. Chamaerops gracilis Lodd.
Figs 7, 8. Chamaerops humilis L.
Figs 9, 10. Chamaerops martiana Wallich
Figs 11, 12. Copernicia alba Morong
Figs 13, 14. Copernicia cerifera Mart.
Figs 15, 16. Copernicia glabrescens Wendl. et Becc.
Figs 17, 18. Corypha elata Roxb.
Figs 19, 20. Corypha umbraculifera L.
Figs 21, 22. Erythea armata Wats.
Figs 23, 24. Erythea edulis Wats.
Figs 25, 26. Licuala fordiana Becc.
Figs 27, 28. Livistona chinensis Mart.
Fig. 29. Livistona subglobosa Mart.
Magn.: ×1000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61. **Erythea armata** Wats. 161-517-1 (Plate VII, 21, 22)

Monosulcate pollen grains, exine tectate inperforate. Surface smooth or finely scabrate. Exine 1.5 μ thick, tectum, infratectum and nexine are of identical thickness. Structure elements are difficult to be distinguished by the light microscope, they are probably of granular type.
Longitudinal axis: 32—40 μ.

62. **Erythea edulis** Wats. 161-517-2 (Plate VII, 23, 24)

With the exception of measure, it is identical with the preceding species.
Longitudinal axis: 36—42 μ.

63. **Licuala fordiana** Becc. 161-129-1 (Plate VII, 25, 26)

Monosulcate pollen grains, exine tectate inperforate. Surface smooth or finely scabrate. Exine 0.8—1 μ thick, tectum, infratectum and nexine is of identical thickness.
Longitudinal axis: 22—28 μ.

64. **Livistona chinensis** Mart. 161-1221-1 (Plate VII, 27, 28)

Monosulcate pollen grains, exine tectate inperforate. Surface smooth or finely scabrate. Exine thickness 1 μ. Infratectum slightly thicker than the tectum and nexine. Structure intrabaculate.
Longitudinal axis: 23—27 μ.

65. **Livistona subglobosa** Mart. 161-1221-2 (Plate VII, 29, Plate VIII, 1)

Monosulcate pollen grains, exine reticulate, reticulum lumen diameter is in general below 0.5 μ. Exine thickness 1—1.5 μ, tectum, infratectum and nexine are of identical thickness.
Longitudinal axis: 30—38 μ.

66. **Rhapis excelsa** (Thunb.) Henry 161-178-1 (Plate VIII, 2, 3)

Monosulcate pollen grains, exine tectate inperforate, surface finely granulate. Exine 0.8—1 μ thick, the three layers are of identical thickness. Structure elements are not clearly distinguishable, probably short bacula.
Longitudinal axis: 22—26 μ.

67. **Sabal mexicana** Mart. 161-181-4 (Plate VIII, 4, 5)

Monosulcate pollen grains, exine reticulate, reticulum lumen diameter 0.4 μ in general. Exine thickness 1.5—2 μ. Infratectum thicker than tectum and nexine.
Longitudinal axis: 25—35 μ.

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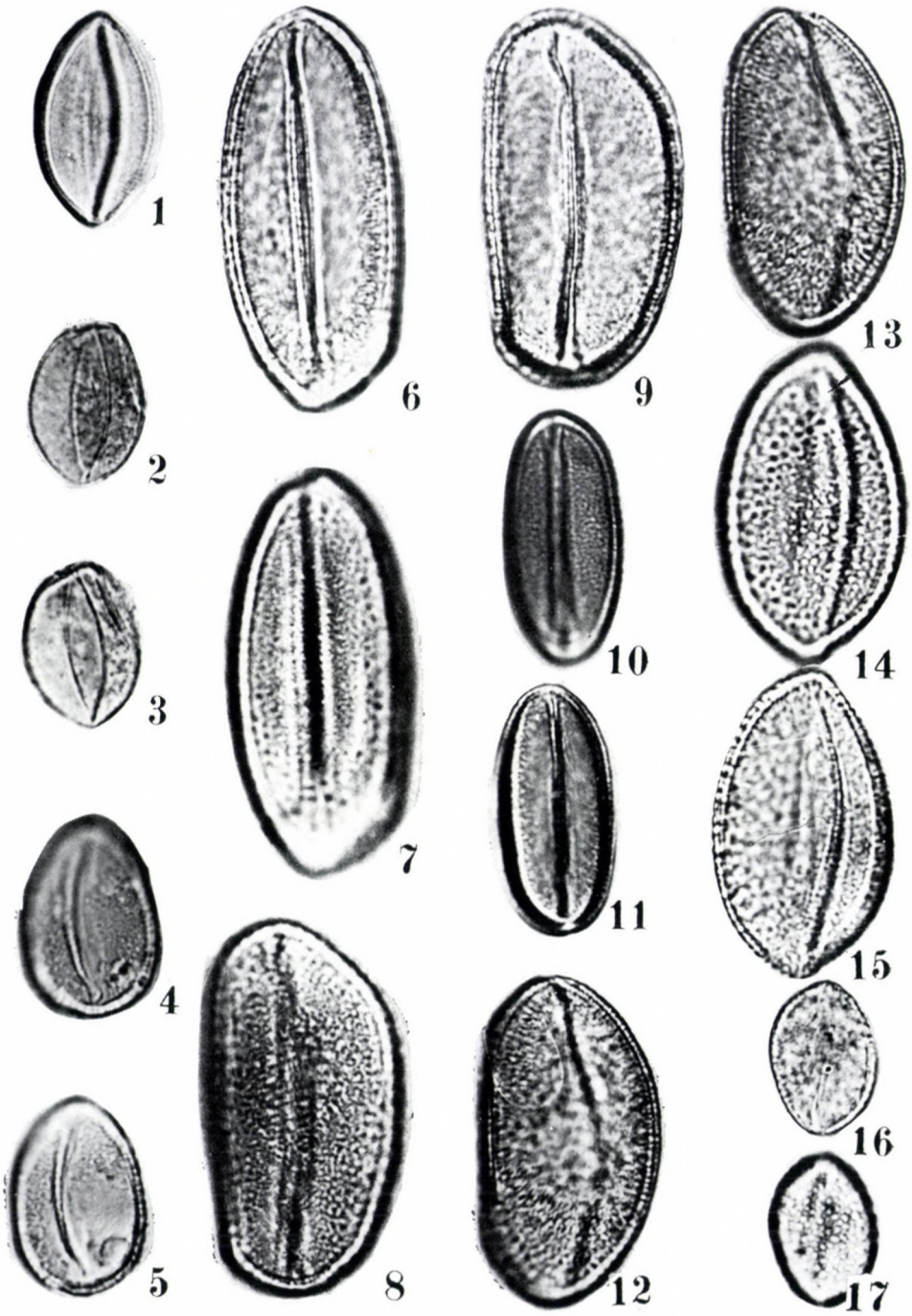
Plate VIII

Fig. 1. Livistona subglobosa Mart.
Figs 2, 3. Rhapis excelsa (Thunb.) Henry
Figs 4, 5. Sabal mexicana Mart.
Figs 6, 7. Sabal minor Pers.
Figs 8, 9. Sabal palmetto (Walt.) Lodd.
Figs 10, 11. Serenoa repens (Barth) Small
Figs 12, 13. Serenoa serrulata (Roem. et Schult.) Hook
Figs 14, 15. Trachycarpus excelsa (Thunb.) Wendl.
Figs 16, 17. Trachycarpus fortunei H. Wendl.
Magn.: $\times 1000$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68. **Sabal minor** Pers. 161-181-5 (Plate VIII, 6, 7)

Monosulcate pollen grains, exine tectate perforate. Perforations lie sparsely. Surface smooth or finely scabrate. Exine 2—3 μ thick, tectum is thicker than infratectum or nexine. Structure intrabaculate.
Longitudinal axis: 50—60 μ.

69. **Sabal palmetto** (Walt.) Lodd. 161-181-7 (Plate VIII, 8, 9)

Exine in general is 2 μ thick. Other characteristics are identical with those of the preceding species.
Longitudinal axis: 42—55 μ.

70. **Serenoa repens** (Barth) Small 161-185-1 (Plate VIII, 10, 11)

Monosulcate pollen grains, exine reticulate. Reticulum lumen diameter 0.3—0.4 μ. Exine thickness 1.5—1.8 μ, infratectum is thicker than tectum or nexine.
Longitudinal axis: 32—38 μ.

71. **Serenoa serrulata** (Roem. et Schult.) Hook. 161-185-2 (Plate VIII, 12, 13)

Reticulum lumen diameter slightly greater than that in the preceding species. Exine thickness 2—2.5 μ, nexine is thinner than the two outer layers.
Longitudinal axis: 44—45 μ.

72. **Trachycarpus excelsa** (Thunb.) Wendl. 161-1917-1 (Plate VIII, 14, 15)

Monosulcate pollen grains, exine reticulate. Reticulum lumen diameter 1 μ in general, muri width 0.5 μ. Exine thickness 1.6—2 μ, tectum is the thickest of the layers.
Longitudinal axis: 38—46 μ.

73. **Trachycarpus fortunei** H. Wendl. 161-1917-2 (Plate VIII, 16, 17)

Monosulcate pollen grains, exine reticulate, reticulum lumen diameter 1μ in general, muri width 2.5 μ. Exine thickness 1.5 μ of the three layers of ectexine tectum is the thickest,
Longitudinal axis: 38—46 μ.

74. **Washingtonia filifera** Wendl. 161-211-1 (Plate IX, 1, 2)

Monosulcate pollen grains, exine reticulate. Reticulum lumen diameter 0.3 μ in general. Exine thickness 1.5 μ, ectexine three layers are of identical thickness.
Longitudinal axis: 30—38 μ.

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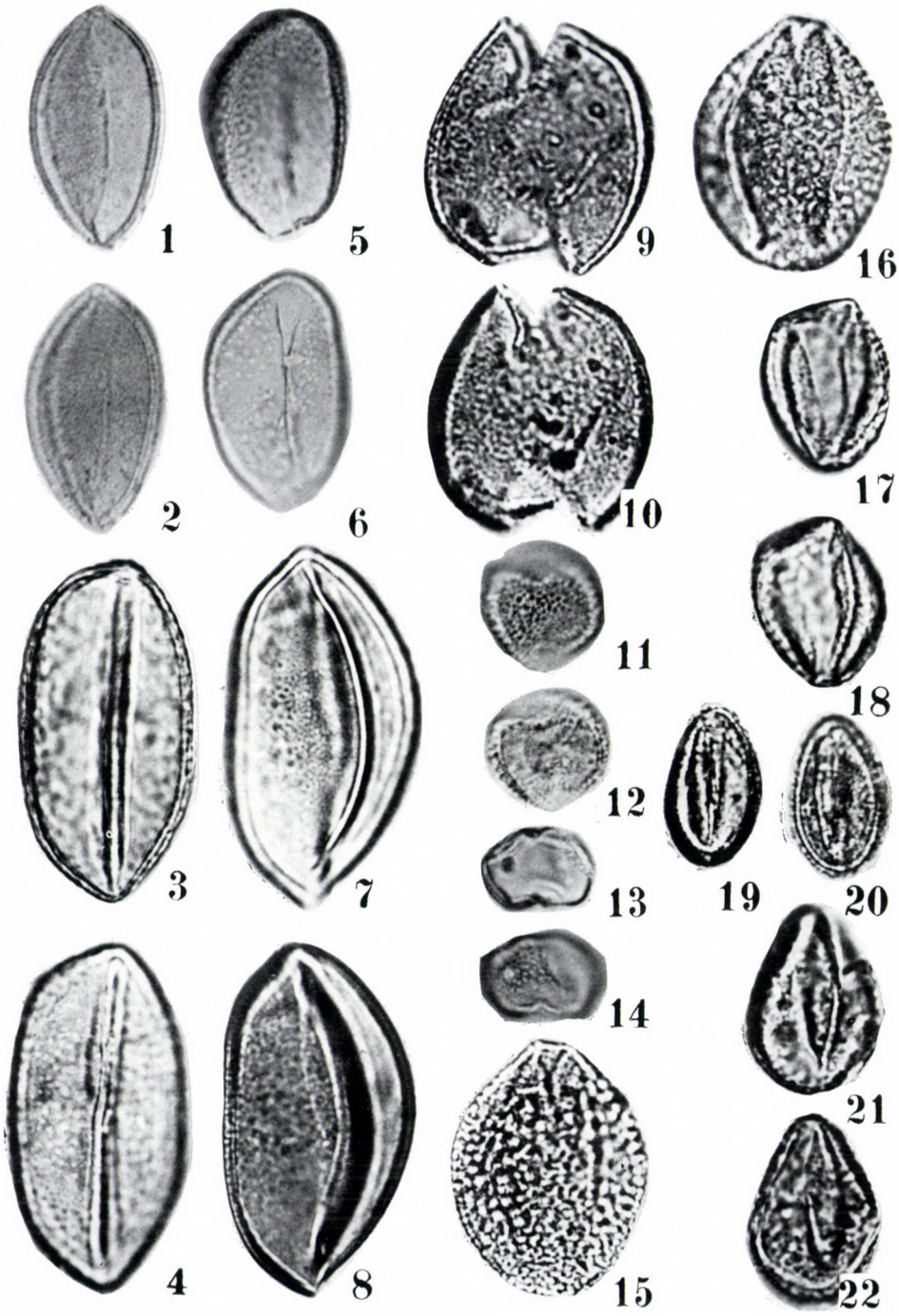
Plate IX

Figs 1, 2. Washingtonia filifera Wendl.
Figs 3, 4. Coccothrinax argentata (Jacq.) Bailey
Figs 5, 6. Thrinax parviflora Sw.
Figs 7, 8. Ancistrophyllum secudiflorum Wendl.
Figs 9, 10. Calamus andamaniacus Kurz.
Figs 11, 12. Calamus diepenhorsti var. *exulans* Becc.
Figs 13, 14. Calamus guruba Ham.
Figs 15, 16. Calamus longisetus Griff.
Figs 17, 18. Calamus palustris Griff.
Figs 19, 20. Calamus rotang L.
Figs 21, 22. Calamus secundiflorus Beanv.
Magn.: $\times 1000$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75. **Coccothrinax argentata** (Jacq.) Bailey 161-315-1 (Plate IX, 3, 4)

Monosulcate pollen grains, exine tectate perforate, surface smooth or finely scabrate. Tectum perforations very small, with 0.1—0.2 μ diameter. Exine 2 μ thick, infratectum is thicker than the tectum and the nexine. Structure intrabaculate.
Longitudinal axis: 48—55 μ.

76. **Thrinax parviflora** Sw. 161-198-4 (Plate IX, 5, 6)

Monosulcate pollen grains, exine reticulate. Reticulum lumen below 0.5 μ. Muri width 2—2.5 μ, nexine thinner than the two outer ectexine layers.
Longitudinal axis: 44—45 μ.

Lepidocaryioideae

Ancistrophylleae

77. **Ancistrophyllum secundiflorum** Wendl. 161-114-1 (Plate IX, 7, 8)

Monosulcate pollen grains, exine surface finely reticulate. Exine thickness around 1 μ, infratectum slightly thicker than tectum or nexine.
Longitudinal axis: 40—50 μ.

Calameae

78. **Calamus andamaniacus** Kurz. 161-31-1 (Plate IX, 9, 10)

Disulcate pollen grains, surface rugulate. Sculpture fine, exine 1.5 μ thick, tectum thicker than infratectum or nexine. Structure intrabaculate.
Longitudinal axis: 34—38 μ.

79. **Calamus diepenhorsti** var. **exulans** Becc. 161-31-2 (Plate IX, 11, 12)

Disulcate pollen grains, surface clavate. Measure of capituli is always below 1 μ, generally 0.3—0.6 μ and they lie densely. Sexine is thicker than nexine, exine is 1.5—2 μ thick.
Longitudinal axis: 12—18 μ.

80. **Calamus guruba** Ham. 161-31-4 (Plate IX, 13, 14)

Disulcate pollen grains, exine reticulate, reticulum lumen diameter 0.6 μ in general. Exine thickness below 1 μ. Tectum, infratectum and nexine are of identical thickness.
Longitudinal axis: 14—17 μ.

81. **Calamus longisetus** Griff. 161-31-5 (Plate IX, 15, 16)

Disulcate pollen grains. Exine ornamentation is essentially rugulate, however, it is rather varying, verrucate or reticulate. Ornamental elements width 1 μ in general. Exine 1.5 μ thick, tectum is thicker than infratectum or nexine. Structure is intrabaculate.
Longitudinal axis: 34—40 μ.

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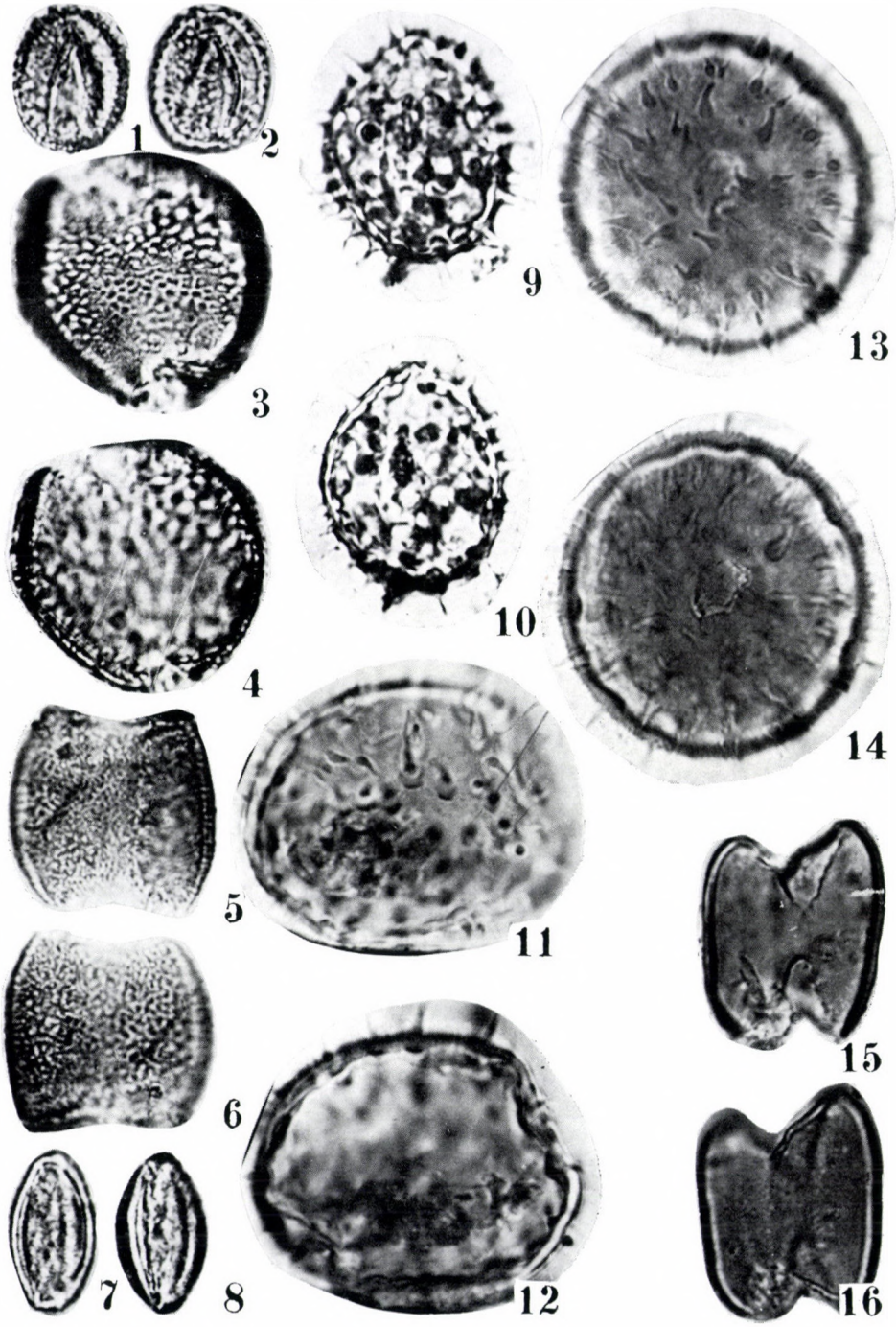
Plate X

Figs 1, 2. Calamus tetradactylis Hance
Figs 3, 4. Calamus thysanolepis Hance
Figs 5, 6. Calamus walkeri Hance
Figs 7, 8. Daemonorops melanochaetes Bl.
Figs 9, 10. Lepidocaryum gracile Burret
Figs 11, 12. Mauritia flexuosa L.
Figs 13, 14. Mauritia martiana Sprc.
Figs 15, 16. Metroxylon sagu Rottb.
Magn.: $\times 1000$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82. **Calamus palustris** Griff. 161-31-6 (Plate IX, 17, 18)

Disulcate pollen grains, surface rugulate. Sculpture element length generally 1 μ. Exine 1.5—2 μ thick, tectum slightly thicker than the other two layers.
Longitudinal axis: 24—30 μ.

83. **Calamus rotang** L. 161-31-8 (Plate IX, 19, 20)

Disulcate pollen grains, exine reticulate. Reticulum lumen diameter below 0.5 μ, tectum, infratectum and nexine are of identical thickness.
Longitudinal axis: 17—25 μ.

84. **Calamus secundiflorus** Beanv. 161-31-9 (Plate IX, 21, 22)

Morphological characteristics of pollen grains are identical with those of the preceding species with the exception of infratectum which is slightly thinner than the outer and the inner layers.
Longitudinal axis: 26—30 μ.

85. **Calamus tetradactylis** Hance 161-31-10 (Plate X, 1, 2)

Disulcate pollen grains, exine reticulate. Reticulum lumen diameter 1 μ in general. Exine thickness 1.5 μ, tectum is the thickest of the three layers.
Longitudinal axis: 18—24 μ.

86. **Calamus thysanolepis** Hance 161-31-11 (Plate X, 3, 4)

Disulcate pollen grains, exine reticulate. Reticulum lumen diameter 1.5—2 μ, muri width 1 μ, exine 1 μ thick, infratectum is the thickest among the layers.
Longitudinal axis: 36—44 μ.

87. **Calamus walkeri** Hance 161-31-12 (Plate X, 5, 6)

Disulcate pollen grains, exine reticulate. Reticulum lumen diameter is identical with that of the preceding species. Exine is 1.5—2 μ thick, the three layers are of identical size.
Longitudinal axis: 30—38 μ.

88. **Daemonorops melanochaetes** Bl. 161-41-1 (Plate X, 7, 8)

Disulcate pollen grains, surface reticulate. Reticulum lumen diameter 0.2—0.4 μ muri width 0.3 μ. Exine thickness 1 μ in general, the three layers are of identical thickness.
Longitudinal axis: 17—25 μ.

Mauritieae

89. **Lepidocaryum gracile** Burret 161-125-1 (Plate X, 9, 10)

Monosulcate pollen grains, exine supratectate, echinate. Sculpture is of two kinds, on the one hand thorns, on the other hands great; 4—5 μ long spines. Exine 2—2.5 μ thick, the three layers are of identical thickness. Infratectum elements are not well distinguishable under the light microscope, the structure is probably intrabaculate.
Longitudinal axis: 38—45 μ.

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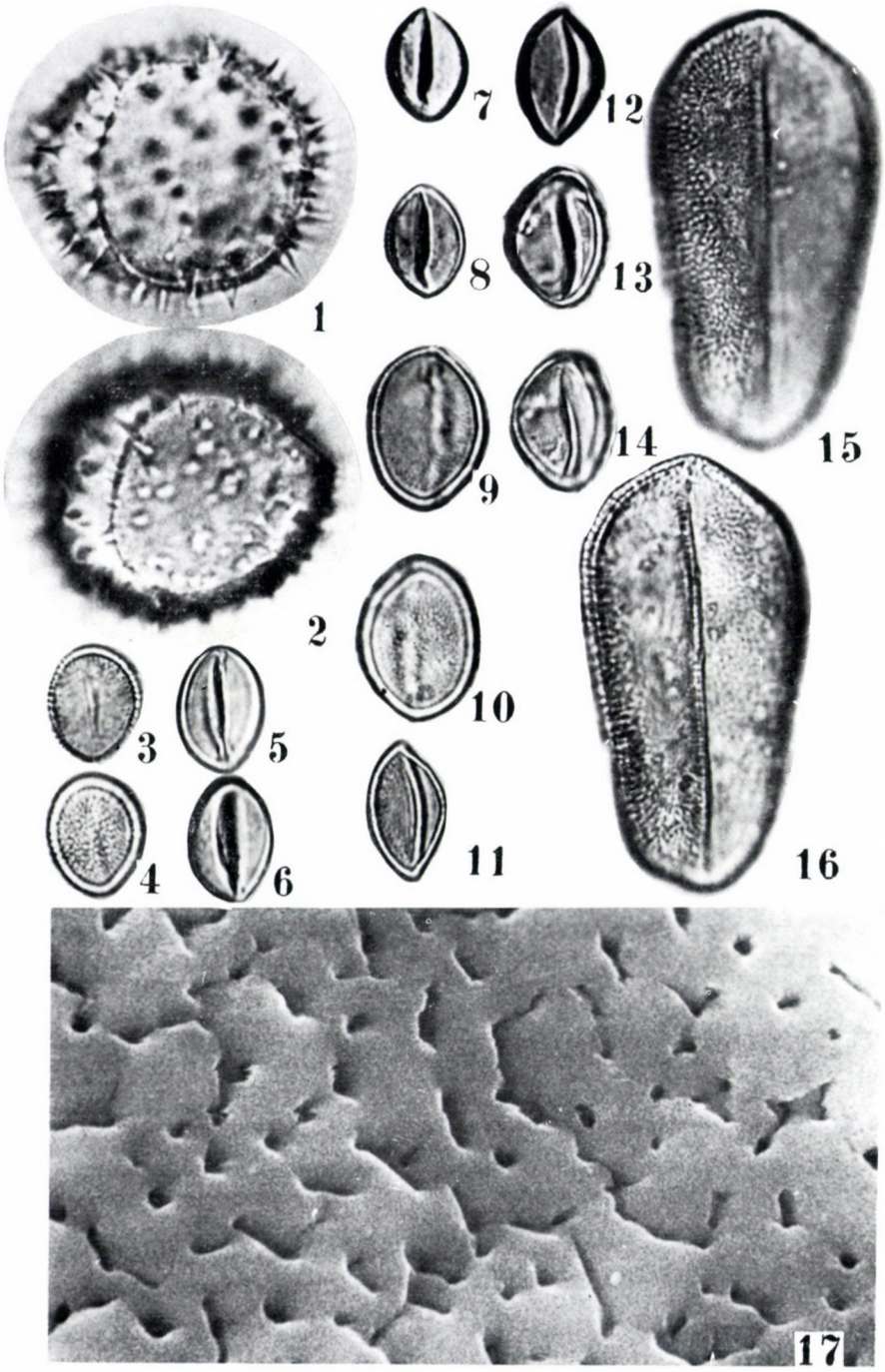
Plate XI

Figs 1, 2. Nypa fruticans Wurmb., magn.: ×1000
Figs 3, 4. Phoenix acaulis Roxb., magn.: ×1000
Figs 5, 6. Phoenix dactylifera L., magn.: ×1000
Figs 7, 8. Phoenix pusilla Gaertn., magn.: ×1000
Figs 9, 10. Phoenix reclinata Jacq., magn.: ×1000
Figs 11, 12. Phoenix robusta Hook, magn.: ×1000
Figs 13, 14. Phoenix zeylandica Trim., magn.: ×1000
Figs 15, 16. Phytelephas poeppigii Gard., magn.: ×1000
Fig. 17. Astrocaryum argenteum Hort., magn.: ×10,000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90. **Mauritia flexuosa** L. 161-131-1 (Plate X, 11, 12)

Ulcerate pollen grains, exine with supratectate spinae. On the basis of the spinae size it is of two kinds. The large ones are 4—5 μ long and strongly thicken on their base. Exine tectate perforate, perforations are very small. Its thickness 1.5—2 μ, the three layers are of identical size. The infratectum elements are not detectable under the light microscope.
Diameter: 40—50 μ.

91. **Mauritia martiana** Sprc. 161-131-2 (Plate X, 13, 14)

Morphological characteristics of the pollen grains are essentially identical with those of the preceding species.
Diameter: 43—50 μ.

92. **Metroxylon sagu** Rottb. 161-135-1 (Plate X, 15, 16)

Disulcate pollen grains, surface smooth, exine tectate inperforate. Exine thickness 2 μ in general, tectum, infratectum and nexine are of identical thickness. Structure elements seem to be of granular structure under the light microscope.
Longitudinal axis: 30—35 μ.

Nypoideae

93. **Nypa fruticans** Wurmb. 161-149-1 (Plate XI, 1, 2)

Ample data in the literature are available on the pollen grains of this species, and on the fossil pollen grain of the genera. Exine tectate, perforate, spinae are 6—8 μ long and broaden on its base. Exine is 1.5—2 μ thick, infratectum is thicker than the tectum or the nexine. Structure intrabaculate.
Longitudinal axis: 45—60 μ.

Phoenicoideae

94. **Phoenix acaulis** Roxb. 161-1615-1 (Plate XI, 3, 4)

Monosulcate pollen grains, surface reticulate, reticulum diameter up to 0.5 μ. Exine thickness generally 1 μ. Infratectum is slightly thicker than the tectum and nexine.
Longitudinal axis: 14—18 μ.

95. **Phoenix dactylifera** L. 161-1615-3 (Plate XI, 5, 6)

Monosulcate pollen grains, exine tectate inperforate. Surface scabrate. Exine thickness generally below 1 μ, tectum, infratectum and nexine are of identical thickness. Structure pronounced intrabaculate.
Longitudinal axis: 14—18 μ.

96. **Phoenix pusilla** Gaertn. 161-1615-6 (Plate XI, 7, 8)

Monosulcate pollen grains, surface reticulate, reticulum lumen below 0.5 μ; around 0.3 μ. Exine 1 μ thick, the three layers are identical.
Longitudinal axis: 14—17 μ.

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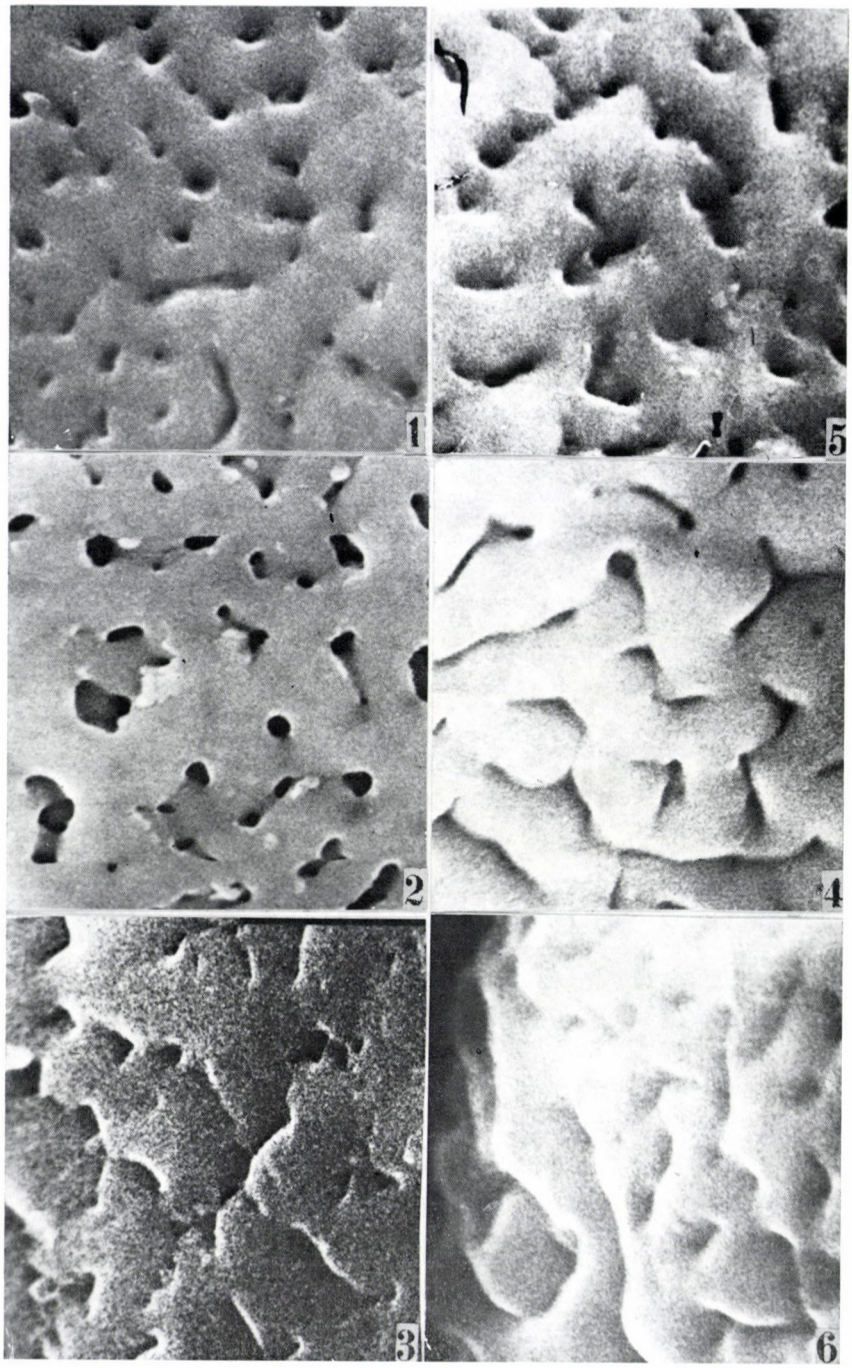
Plate XII

Fig. 1. Astrocaryum mexicanum Liebm.
Fig. 2. Ancistrophyllum secundiflorum Wendl.
Fig. 3. Bactris minor Jacq.
Fig. 4. Brahea serrulata R. et Sch.
Fig. 5. Calamus andamaniacus Kurz.
Fig. 6. Calamus palustris Griff.
Magn.: $\times$10,000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97. **Phoenix reclinata** Jacq. 161-1615-2 (Plate XI, 9, 10)

Pollen morphology is identical with that of the preceding species.
Longitudinal axis: 20—24 μ.

98. **Phoenix robusta** Hook. 161-1615-8 (Plate XI, 11, 12)

Morphological characteristics are identical with those of the preceding species.
Longitudinal axis: 17—22 μ.

99. **Phoenix zeylandica** Trim. 161-1615-9 (Plate XI, 13, 14)

The morphological characteristics of the pollen grain are identical with those of the preceding species.
Longitudinal axis: 17—20 μ.

Phytelephantoideae

100. **Phytelephas poeppigii** Gard. 161-1623-1 (Plate XI, 15, 16)

Monosulcate pollen grains, surface reticulate, reticulum lumen diameter 1—1.3 μ, muri width 0.3—0.4 μ; exine 2—2.8 μ, infratectum is thicker than tectum or nexine.
Longitudinal axis: 56—65 μ.

Scanning electronmicroscopical examination of some of the Palmae pollen grains

Astrocaryum argenteum Hort. (Plate XI, 17)

Surface uneven, diameter of the perforations in many cases is not circular, but longly elongating. Light microscopically this sculpture seems to be finely reticulate.

Astrocaryum mexicanum Liebm. (Plate XII, 1)

Perforation diameter is also different, however, the occurrence of the long elongated perforation is rarer than in the preceding species.

Ancistrophyllum secundiflorum Wendl. (Plate XII, 2)

Perforations of the tectum are extremely varying in size and form. Circular ellyptic, approximately triangular, or elongated forms are possible. Surface smooth. Light microscopically the surface is the same as that of Astrocaryum argenteum, any difference is detectable only under the scanning electron microscope.

Bactris minor Jacq. (Plate XII, 3)

Perforation forms are varying, mostly lengthwise elongating, and only rarely circular. Thus the surface picture is similar to rugulate ornamentation. These characteristics cannot be observed under the light microscope.

Brahea serrulata R. et Sch. (Plate XII, 4)

Tectum perforations are of circular of lengthwise elongating form, the submicroscopic surface is similar to that of *Bactris minor*.

Calamus andamaniacus Kurz. (Plate XII, 5)

Perforations viewed from above are only rarely of circular form, the lengthwise elongating, anastomozing perforations bring about fine rugulate surfaces.

Calamus palustris Griff. (Plate XII, 6)

Scanning surface ornamentation essentially is identical with that of the preceding species.

Summary

In the course of our examinations, we described mainly monosulcate pollen grains, and besides them, trichotomosulcate, disulcate and ulcerate types of species. Although the monosulcate form is generally characteristic of Palmae, further types are also known. Thus THANIKAIMONI (1966) described triporate (*Sclerosperma mannii* Wendl.), of elliptic sulcus (*Syagurus* Mart.) (1966, 1970), and diporate (*Daemonorhops verticillaris*, *Elaeiodoxa*, *Karthalsia laciniosa*, *K. rigida*) pollen grains. Since MAHABALÉ (1967) and THANIKAIMONI (1970) dealt in detail with the taxonomic value of *Palmae* pollen morphology, we do not dwell upon this question.

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Note. — For more data on recent Palmae pollen grains see the works of THANIKAIMONI (1966, 1970) and of SOWUNMI (1972).

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SPATIAL PROCESSES IN A GRASSLAND COMMUNITY, II

NUMBER OF INDIVIDUALS, COVER AND BIOMASS AT POPULATION LEVEL*

By

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This paper deals with the changes of some vegetation characteristics (number of individuals, cover and living phytomass) in space at population level continuing the investigations of the community level described in Part I.

The sampling was carried out by randomly located independent quadrats of five different sizes (from 0.04 m^2 to 1.0 m^2).

The characteristics do not show systematic changes of the seasons apart from a few cases. Although the investigated species were predominant conclusions cannot be drawn from their separate changes with respect to the whole community.

Strong positive linear correlations have been found between the different characteristics of the separate species. On the basis of these results the population of *Fumana procumbens* separates from the other species.

These marked and significant correlations enable any characteristic to be calculated from one of the others for the species examined.

Strong positive linear relations could also be established between the characteristics and the area.

The percentage difference between measured and calculated values of characteristics belonging to the plot size of 1.0 m^2 are given, too.

Introduction

The aim of the study and a brief survey of the literature are to be found in Part I (MOLNÁR and NOSEK 1980).

This paper deals with the changes of characteristics of several species in space at population level.

As the present paper is closely related to Part I, it is useful to outline — even if briefly — the previous results at community level.

The total number of individuals and the number of species reflected the seasonal aspects of the community well. The number of species showed a logarithmic, the other characteristics showed positive linear correlations to the area. Comparing the seasonal changes to the changes in the function of area the slightest and steepest slopes were established in the season when the different characteristics showing any systematic changes with the aspects reached their minimal and/or maximal values. Positive linear correlations were found between the various pairs of the characteristics investigated. There were seasonal differences in the slopes of curves.

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1. Material and methods

1.1. A detailed description of the sampling area and basic techniques can be found in Part I.

1.2. From the 15 species occurring in the sampling area six were drawn into the investigations at population level. These are: *Festuca vaginata*, *Thymus* sp., *Fumana procumbens* and *Carex stenophylla* in all seasons, *Arenaria serpyllifolia* in spring and *Medicago minima* in autumn. In the case of the other species (and the other seasons of *Arenaria* and *Medicago*) there were inadequate data to make a statistical analysis.

Three characteristics were investigated: number of individuals, cover and biomass.

1.3. The following uniform designations and symbols are used: N_i — the number of individuals, C_i — the cover, B_{Li} — the biomass (living phytomass) of the i-th species and A_j — the area of the quadrat.

In the actual cases the indices Fe, Th, Fu, Ca, Ar and Me instead of i denote the species *Festuca*, *Thymus*, *Fumana*, *Carex*, *Arenaria* and *Medicago*, respectively.

The value of j changes from 1 to 5. A_1 correspond to the plot size of 0.04 m², A_2 to 0.16 m², A_3 to 0.36 m², A_4 to 0.64 m² and A_5 to 1.0 m².

$$\sum_{i=1}^{S} N_i = N_T, \quad \sum_{i=1}^{S} C_i = C_T, \quad \sum_{i=1}^{S} B_{Li} = B_{LT}$$

where S is the number of species, N_T, C_T, B_{LT} are the corresponding values of the community.

The original layout of each plot size was made in three replications in the field. These will be mentioned further as "field replications".

To reduce the error of estimation the sample size was increased repeating the sampling on the basis of the maps. On the map of each plot size we put randomly one quadrat of the smaller ones each (e.g. on the 1.0 m² size the plots of 0.04, 0.16, 0.36 and 0.64 m²). In this way we obtained the following number of replications: 12, 9, 6, 3 and 0 for A_j, from $j = 1$ to $j = 5$, respectively. This kind of replication will be called "map replications".

The addition of map replications to the corresponding field replications resulted in the so-called "combined replications" with the numbers 15, 12, 9, 6 and 3 ($j = 1, \ldots, 5$).

The distinction of these three types is made by the upper right "f", "m" and "k" indices in the separate variables (X_i^f, X_i^m, X_i^k).

Averages are marked with an upper dash ($^-$). Note:

$$\overline{X}_{i5}^f = \overline{X}_{i5}^k \qquad \overline{X}_{ij}^k = \frac{\sum X_{ij}^f + \sum X_{ij}^m}{n_j^f + n_j^m}$$

1.4. In the case of *Carex* and *Medicago* the cover values could not be measured exactly on the maps owing to the small size of the individuals. Therefore 50 specimens each were measured by planimeter in their original size. To get the cover values the average of these was multiplied by the number of individuals.

1.5. The standard error of the mean (S.E.) was calculated by the formula of

$$\frac{\text{standard deviation}}{\sqrt{\text{number of replications}}}.$$

The test of linearity was made according to WAINRIGHT and GILBERT (1977).

2. Results and discussion

2.1. Seasonal changes

The investigation of seasonal changes was limited to the following four species: *Festuca*, *Thymus*, *Fumana* and *Carex* because the others were not present in every season. These species differ from each other both in life form

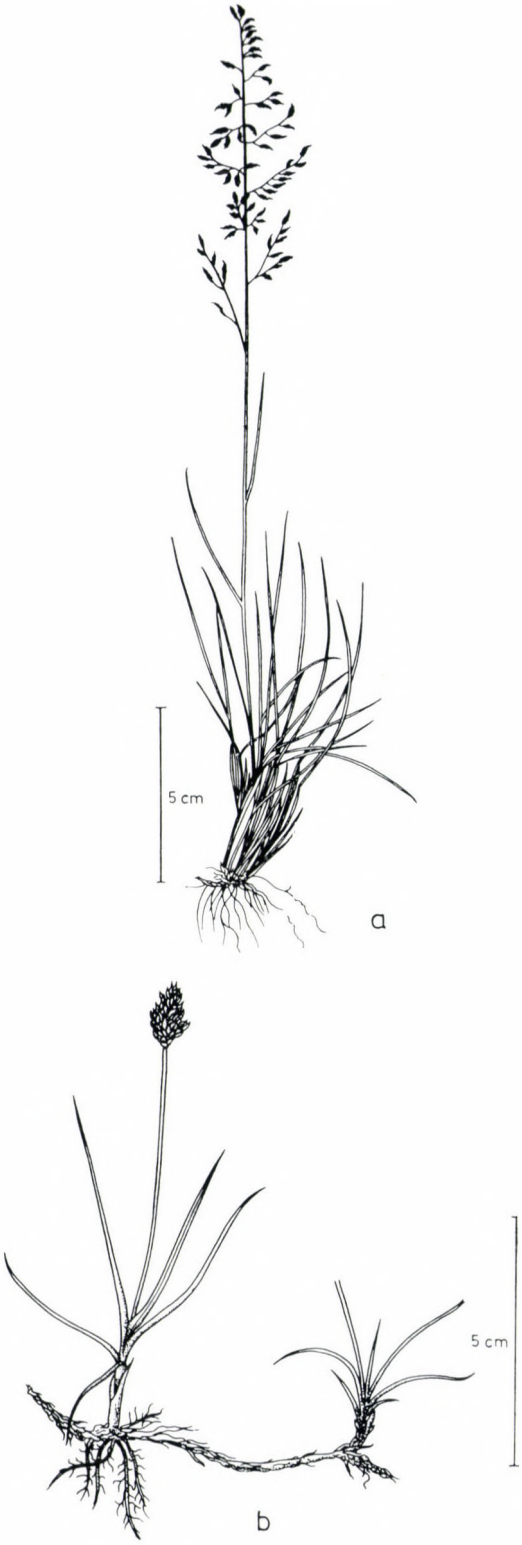

Fig. 1a, b

Fig. 1. The habitus of four dominant species (after V. Csapody in Jávorka—Csapody 1975. a) *Festuca*, b) *Carex*, c) *Fumana*, d) *Thymus*)

and in reproductive strategy. They represent four life forms according to RAUNKIER. These are (in the above-mentioned order of species): Hemicryptophyte, Chamaephyte, Nanophanerophyte and Geophyte (for the habitus of species see Fig. 1).

Unequivocal correlation with the seasons were indicated only by the number of individuals and living phytomass of *Festuca* as well as the cover and living phytomass of *Thymus*. From spring till autumn the $\overline{N}^k_{Fe}$, $\overline{B}^k_{LFe}$ and $\overline{C}^k_{Th}$ increased apart from plot sizes of A_3, A_1 and A_5, respectively. $\overline{B}^k_{LTh}$ gave a summer minimum in all plot sizes which could be explained by the smaller adaptability of this species than that of the others to the period of drought. The other characteristics did not show systematic changes. In general all characteristics reach their maximal values in autumn.

Comparing the population level with the community level the $\overline{N}^k_{ij}$, $\overline{C}^k_{ij}$ and $\overline{B}^k_{Lij}$ values (Tables 1, 2 and 3) do not show such systematic changes on the effect of the seasons as the $\overline{N}^f_{Tj}$, $\overline{C}^f_{Tj}$ and $\overline{B}^k_{Tij}$ variables (cf. Part I).

The behaviour of the population of the separate species differs considerably from that of the community as a whole. Although these four species form the majority of the characteristics examined and are present in every season, we cannot draw any conclusions from their changes with respect to the whole community.

2.2. The relation between the separate characteristics

2.2.1. Correlation and linear regression analysis was made between the different characteristics. All calculations were made on the basis of the field replications (X^f_{ij}).

Strong positive linear correlation was found in all cases (Tables 4 and 5). These strong and significant correlations enable any characteristics to be calculated from one of the other for the species examined in this community. The tables do not contain the pairs N^f_{Ca} — C^f_{Ca} and N^f_{Me} — C^f_{Me}. The explanation of their neglect is to be found in *1.4*. The equal correlation coefficients of N^f_{Ca} — B^f_{LCa}, C^f_{Ca} — B^f_{LCa}, N^f_{Me} — B^f_{LMe} and C^f_{Me} — B^f_{LMe} in the various seasons have the same explanation.

2.2.2. Number of individuals and cover

Examining the relations, the regression coefficient values (b_i) are the lowest in spring at each species. The slope of the curves in summer and autumn are significant steeper than in spring, and are similar to each other. It is demonstrated by an example taken at random in Fig. 2. In our opinion it refers to the fact the increase in cover of species examined is more intensive from spring till summer than from summer till autumn.

Table 1

The values of different characteristics as the function of plot size in spring

A_j	0.04	0.16	0.36	0.64	1.0
n	15	12	9	6	3
$\overline{N}^k_{Fe}$	4.40	13.75	28.78	46.50	71.00
	1.35	3.33	2.82	5.99	8.19
	0.35	0.96	0.94	2.45	4.73
$\overline{C}^k_{Fe}$	136.77	500.93	1010.22	1869.80	2259.73
	72.75	225.08	442.37	814.34	1095.47
	18.78	64.97	147.46	332.45	632.47
$\overline{B}^k_{LFe}$	1.65	6.27	13.19	23.61	40.03
	1.05	2.91	5.03	11.36	15.14
	0.27	0.84	1.68	4.64	8.74
$\overline{N}^k_{Th}$	3.27	6.83	16.11	27.00	71.00
	2.32	5.25	13.16	20.17	21.00
	0.60	1.52	4.38	8.23	12.12
$\overline{C}^k_{Th}$	35.20	130.70	312.57	754.53	1426.40
	31.00	85.24	288.37	494.83	606.56
	8.00	24.61	96.13	202.02	350.19
$\overline{B}^k_{LTh}$	0.92	1.63	4.10	6.86	11.48
	0.53	0.52	2.61	4.04	6.39
	0.14	0.15	0.87	1.65	3.69
$\overline{N}^k_{Fu}$	1.00	3.25	5.55	5.16	12.33
	1.00	3.22	3.87	4.58	3.06
	0.26	0.93	1.29	1.87	1.76
$\overline{C}^k_{Fu}$	11.84	54.70	119.20	123.66	306.93
	18.05	56.37	75.04	68.94	91.83
	4.66	16.27	25.01	24.14	53.02
$\overline{B}^k_{LFu}$	0.58	1.88	4.64	3.91	7.61
	0.60	1.60	2.98	1.75	5.44
	0.16	0.46	0.99	0.71	3.14
$\overline{N}^k_{Ca}$	1.33	10.92	22.55	45.50	65.00
	1.87	11.02	13.76	28.07	65.18
	0.48	3.18	4.58	11.46	37.63
$\overline{C}^k_{Ca}$	2.13	17.46	46.22	111.20	104.00
	3.00	17.46	44.41	120.53	104.29
	0.77	5.09	14.80	49.21	60.21
$\overline{B}^k_{LCa}$	0.080	0.33	0.83	1.73	1.45
	0.11	0.29	0.58	1.69	1.01
	0.029	0.084	0.19	0.69	0.58
$\overline{N}^k_{Ar}$	3.13	10.75	20.77	47.16	48.00
	3.22	6.59	14.40	25.25	14.18
	0.83	1.90	4.80	10.31	8.19
$\overline{C}^k_{Ar}$	3.13	10.75	20.78	58.06	58.10
	3.23	6.59	14.40	42.18	20.25
	0.83	1.90	4.80	17.22	11.69
$\overline{B}^k_{LAr}$	0.036	0.20	0.52	1.27	1.57
	0.050	0.15	0.36	0.93	1.02
	0.013	0.042	0.12	0.38	0.59

The three values belonging to a given characteristic and plot size are: upper — the average, middle — the standard deviation, lower — the standard error of mean (S.E.); A_j is given in m^2, n — the number of replications

Table 2

The values of different characteristics as the function of plot size in summer

A_j	0.04	0.16	0.36	0.64	1.0
n	15	12	9	6	3
	5.80	15.82	37.00	52.16	93.33
$\overline{N}^k_{Fe}$	1.66	3.43	7.90	10.46	7.64
	0.43	0.99	2.64	4.27	4.41
	107.33	498.33	1219.06	2562.86	4548.20
$\overline{C}^k_{Fe}$	64.88	293.18	497.38	678.27	948.42
	16.75	84.64	165.79	276.90	547.57
	6.38	11.15	20.30	35.41	54.47
$\overline{B}^k_{LFe}$	1.91	3.52	4.21	6.56	7.78
	0.49	1.01	1.40	2.68	4.49
	3.80	8.00	15.66	25.66	32.67
$\overline{N}^k_{Th}$	1.42	4.22	7.21	9.83	11.59
	0.37	1.22	2.40	4.01	6.69
	58.51	192.80	411.86	937.60	1199.07
$\overline{C}^k_{Th}$	35.22	126.93	250.93	461.83	739.03
	9.09	36.64	83.64	188.54	426.68
	0.46	1.18	3.24	5.56	8.71
$\overline{B}^k_{LTh}$	0.31	0.83	2.67	2.59	5.75
	0.08	0.24	0.89	1.06	3.32
	1.13	1.83	3.33	5.16	12.67
$\overline{N}^k_{Fu}$	1.36	1.90	3.16	4.22	6.51
	0.35	0.55	1.05	1.72	3.76
	25.33	62.73	98.84	187.60	592.27
$\overline{C}^k_{Fu}$	35.48	80.08	139.84	189.48	421.77
	9.16	23.12	46.61	77.35	243.51
	0.92	1.71	2.57	4.32	9.82
$\overline{B}^k_{LFu}$	0.92	1.78	2.95	3.11	5.95
	0.24	0.51	0.98	1.27	3.44
	2.66	10.66	30.22	66.33	104.33
$\overline{N}^k_{Ca}$	3.27	10.38	25.72	56.67	95.20
	0.84	2.99	8.57	23.14	54.96
	4.26	17.06	48.35	106.13	166.93
$\overline{C}^k_{Ca}$	5.23	16.62	41.16	90.68	152.31
	1.35	4.80	13.72	37.02	87.94
	0.039	0.20	0.67	1.57	1.96
$\overline{B}^k_{LCa}$	0.057	0.22	0.56	1.36	2.47
	0.015	0.065	0.19	0.56	1.43

The three values belonging to a given characteristic and plot size are: upper — the average, middle — the standard deviation, lower — the standard error of mean (S.E.); A_j is given in m^2, n — the number of replications

2.2.3. Number of individuals and living phytomass

In this case the spring b values of *Festuca*, *Thymus* and *Fumana* are also the lowest. The slopes of *Carex* are almost the same in every season.

Regarding the b_i values of the seasons their ranges become greater and greater in the following order: *Carex*, *Festuca*, *Thymus* and *Fumana* (Fig. 3).

Table 3

The values of different characteristics as the function of plot size in autumn

A_j	0.04	0.16	0.36	0.64	1.0
n	15	12	9	6	3
	7.27	21.17	36.00	60.67	98.33
$\overline{N}^k_{Fe}$	2.37	8.30	8.25	14.69	23.18
	0.61	2.40	2.75	5.99	13.38
	196.15	740.77	1781.29	2792.07	5012.93
$\overline{C}^k_{Fe}$	78.01	246.60	405.38	710.42	1200.29
	20.14	71.19	135.13	290.03	629.99
	3.91	11.68	22.34	38.92	64.07
$\overline{B}^k_{LFe}$	0.96	4.57	5.83	9.29	20.97
	0.25	1.32	1.94	3.79	12.11
	3.67	11.75	19.89	36.50	50.33
$\overline{N}^k_{Th}$	2.02	5.21	4.80	9.20	4.16
	0.52	1.50	1.60	3.76	2.40
	86.39	424.09	1053.64	1817.22	3009.27
$\overline{C}^k_{Th}$	54.35	188.99	306.49	409.57	368.53
	14.03	54.56	102.16	167.21	212.77
	0.93	2.22	4.90	9.18	11.83
$\overline{B}^k_{LTh}$	0.42	0.98	1.74	3.11	3.50
	0.11	0.28	0.58	1.27	2.02
	1.07	3.67	4.78	6.67	12.33
$\overline{N}^k_{Fu}$	1.16	3.28	3.56	5.01	11.50
	0.30	0.95	1.19	2.04	6.64
	15.67	92.94	233.69	421.25	448.27
$\overline{C}^k_{Fu}$	26.24	109.72	227.69	405.66	434.19
	6.78	31.67	75.90	165.61	250.68
	0.63	3.60	4.59	8.27	16.75
$\overline{B}^k_{LFu}$	1.06	4.26	3.04	5.91	15.67
	0.27	1.23	1.01	2.41	9.05
	5.07	15.42	30.89	53.33	104.33
$\overline{N}^k_{Ca}$	3.69	13.45	16.19	37.59	47.37
	0.95	3.88	5.40	15.34	27.35
	10.01	29.29	58.69	101.33	198.23
$\overline{C}^k_{Ca}$	6.60	25.56	30.76	71.41	90.01
	1.70	7.38	10.25	29.15	51.97
	0.23	0.40	0.73	1.23	2.57
$\overline{B}^k_{LCa}$	0.12	0.29	0.42	0.84	0.25
	0.031	0.08	0.14	0.34	0.14
	10.53	34.33	70.67	103.17	184.00
$\overline{N}^k_{Me}$	6.77	22.82	28.12	25.01	98.73
	1.75	6.59	9.37	10.21	57.00
	4.21	13.73	28.27	41.27	73.60
$\overline{C}^k_{Me}$	2.71	9.13	11.25	10.00	39.49
	0.70	2.64	3.75	4.08	22.80
	0.029	0.11	0.21	0.29	0.51
$\overline{B}^k_{LMe}$	0.017	0.10	0.089	0.10	0.35
	0.004	0.03	0.029	0.042	0.20

The three values belonging to a given characteristic and plot size are: upper — the average, middle — the standard deviation, lower — the standard error of mean (S.E.); A_j is given in m^2, n — the number of replications

It is remarkable the b_{Fu} values are higher than that of the other species in every season, especially in autumn. The possibile explanation of this fact is implied in its woody feature.

The species rank of regression coefficients is the same in every season, $b_{Fu} > b_{Fe} > b_{Th} > b_{Ca}$.

2.2.4. Cover and living phytomass

The b_i values in spring are the greatest except *Carex*. The ranges of b_i-s are almost the same at *Festuca*, *Thymus* and *Carex*, about one third than that of *Fumana*.

In the rank of b_i-s, *Fumana* is the first and *Thymus* is the last in each season.

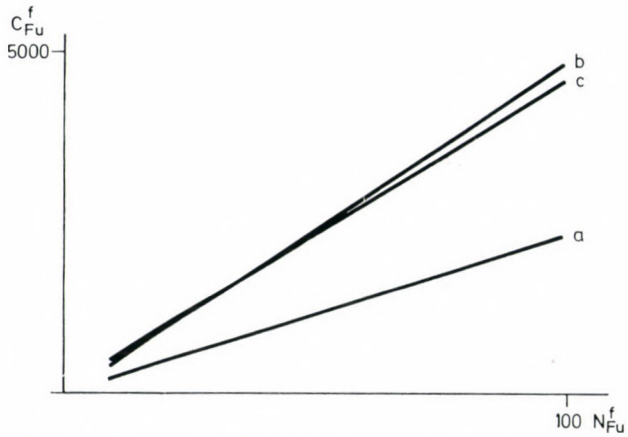

Fig. 2. The regression curves of N^f_{Fu}—C^f_{Fu} pair in the various seasons. a) Spring, b) Summer, c) Autumn

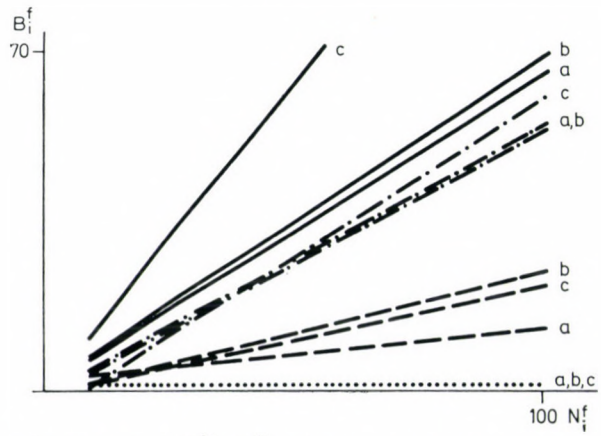

Fig. 3. The regression curves of N^{ij}—B^{ij} pairs in every seasons a) Spring, b) Summer, c) Autumn; —·— *Festuca*, ——— *Fumana*, – – – – *Thymus*, ····· *Carex*

Table 4

The correlation and linear regression coefficients between the different species

Variables		Spring			Summer			Autumn		
X	Y	r	a	b	r	a	b	r	a	b
N^f_{Fe}	C^f_{Fe}	0.8123	161.88	33.58	0.9115	−573.18	48.88	0.9351	−456.36	50.05
N^f_{Fe}	B^f_{LFe}	0.8608	−0.916	0.558	0.9412	−1.452	0.561	0.9357	−5.703	0.662
C^f_{Fe}	B^f_{LFe}	0.8999	−0.349	0.014	0.9832	5.961	0.010	0.9522	1.637	0.012
N^f_{Th}	C^f_{Th}	0.7441	114.45	16.64**	0.8968	−215.43	41.24	0.8736	−150.47	51.23
N^f_{Th}	B^f_{LTh}	0.6192*	2.080	0.117*	0.7984	−1.167	0.264	0.8250	−0.361	0.224
C^f_{Th}	B^f_{LTh}	0.9286	0.888	0.008	0.9314	0.037	0.007	0.8774	0.673	0.004
N^f_{Fu}	C^f_{Fu}	0.9231	−4.778	22.41	0.8978	−47.14	47.20	0.7988	28.09	44.04
N^f_{Fu}	B^f_{LFu}	0.8245	0.187	0.652	0.8030	0.527	0.685	0.9714	−0.859	1.287
C^f_{Fu}	B^f_{LFu}	0.8358	0.579	0.027	0.9379	1.082	0.015	0.7852	1.073	0.018
N^f_{Ca}	B^f_{LCa}	0.9012	0.157	0.021	0.9631	−0.041	0.022	0.8839	0.161	0.020
C^f_{Ca}	B^f_{LCa}	0.9012	0.157	0.013	0.9631	−0.041	0.014	0.8839	0.161	0.010

Levels of significance: * = 5%, ** = 1%; the unmarked r and b values are significant at 0.1%, r — correlation coefficient, a — constant of regression equation, b — regression coefficient, X — independent variable, Y — dependent variable

2.2.5. Comparison of the three pairs of characteristics

The slopes of regression curves of cover — living phytomass pair decrease from spring till autumn contrary to the two other pairs. The reason of this apparent contradiction is to be found in the change of the ratio of the living and dead parts (cf. p. 347 in Part I).

Considering the range and rank of b_i values, the N^f_{ij} — B^f_{Lij} and C^f_{ij} — B^f_{Lij} pairs show more similarity to each other than to the third one (N^f_{ij} — C^f_{ij}). The behaviour of *Fumana* in the case of the former two pairs separates from that of the other species.

It is remarkable that on the basis of the niche studies carried out in the same community (FEKETE et al. 1976, PRÉCSÉNYI et al. 1977a, 1977b) the *Fumana* proved to be a specialist, and also separated from the other species.

2.3. The changes in the function of area

2.3.1. To calculate the correlation and linear regression coefficients we used the values of $\overline{X}^k_{ij}$. As in the case of B_{Lij} there was no possibility to "measure" the values on the basis of the maps, the B^m_{Lij} values were calculated from the linear regression equations of the C^f_{ij} — B^f_{Lij} pair using C^m_{ij} as independent variable (X variable). The strong and significant ($p < 0.1\%$) correlation coefficients make this calculation possibile as it is pointed out by PRÉCSÉNYI (1957).

In all cases strong positive correlations could be established (Tables 6 and 7) between the various characteristics and area.

2.3.2. Number of individuals

$\overline{N}^k_{Fu}$ increases in the slightest degree in the function of the area in every season. The b_{Fe} values increase from spring till autumn. The b_{Fu} and b_{Ca} are the lowest in spring, and reach their maximal value in summer contrary to *Thymus*.

The steepest of the curves gives *Medicago* because of the appearance of seedlings in large numbers in autumn.

Table 5

The correlation and linear regression coefficients between the different of species

Variables		*Arenaria* Spring			*Medicago* Autumn		
X	Y	r	a	b	r	a	b
N^f_i	C^f_i	0.9869	−5.746	1.419			
N^f_i	B^f_{Li}	0.9276	−0.167	0.034	0.9073	0.0004	0.029
C^f_i	B^f_{Li}	0.9427	−0.032	0.024	0.9073	0.0004	0.007

All r and b values are significant at 0.1% level of probability

Table 6

The correlation and linear regression coefficents between the area (X variable) and the different characteristics of the species (Y variable)

Y	Spring			Summer			Autumn		
	r	a	b	r	a	b	r	a	b
$\overline{N}^k_{Fe}$	0.994***	2.629	68.76***	0.9937***	1.865	88.55***	0.9983***	3.888	92.72***
$\overline{C}^k_{Fe}$	0.9615**	165.24	2357.7**	0.9954***	−256.37	4644.5***	0.9959***	−55.13	4908.6***
$\overline{B}^k_{LFe}$	0.9983***	−0.459	39.56***	0.9990***	3.273	50.61***	0.9987***	0.947	61.91***
$\overline{N}^k_{Th}$	0.9592**	−5.048	67.93**	0.9905**	3.621	30.77**	0.9964***	3.002	48.69***
$\overline{C}^k_{Th}$	0.9889**	−110.69	1460.2**	0.9881**	9.498	1251.0**	0.9994***	−53.48	3026.2***
$\overline{B}^k_{LTh}$	0.9973***	0.110	11.10***	0.9992***	−0.007	8.717***	0.9912***	0.612	11.82***
$\overline{N}^k_{Fu}$	0.9418*	0.878	10.38*	0.9586*	−0.242	11.52*	0.9797**	0.960	10.75**
$\overline{C}^k_{Fu}$	0.9573*	0.438	279.18*	0.9335*	−51.94	557.49*	0.9547*	33.33	475.11*
$\overline{B}^k_{LFu}$	0.9354*	0.845	6.541*	0.9646**	−0.037	8.876**	0.9788**	−0.151	15.73**
$\overline{N}^k_{Ca}$	0.9973***	−0.429	67.02***	0.9977***	−5.113	108.99***	0.9889**	−2.419	100.60**
$\overline{C}^k_{Ca}$	0.9261*	3.969	118.71*	0.9977***	−8.194	174.45***	0.9889**	−4.582	191.11**
$\overline{B}^k_{LCa}$	0.8864*	0.171	1.618*	0.9835**	−0.056	2.148**	0.9779**	−0.013	2.377**

Levels of significance: * = 5%, ** = 1%, *** = 0.1%

2.3.3. Cover

The body size of the separate species reflects well in the b_i values. The rank of b_i-s is the same in all season. The behaviour of them is similar to that of $\overline{N}_j^k$ — A_j, except *Carex*.

2.3.4. Living phytomass

The slopes of curves became more and more steeper froms spring till autumn, except *Thymus*, which keeps the "summer decline" but reaches its maximum also in autumn.

2.3.5. The percentage differences between the measured and calculated (on the basis of regression equations) values at 1.0 m² are given in Table 8.

It is necessary to emphasize that the pattern of species is of great importance in studying the vegetation characteristics as a function of plot size.

Table 7

The correlation and linear regression coefficients between the area (X variable) and the different characteristics of the species (Y variable)

Y	*Arenaria* Spring			*Medicago* Autumn		
	r	a	b	r	a	b
$\overline{N}_i^k$	0.9486*	3.620	50.78*	0.9943***	3.927	174.12***
$\overline{C}_i^k$	0.9415*	2.055	63.88*	0.9943***	1.569	69.65***
$\overline{B}_{Li}^k$	0.9828**	−0.033	1.712**	0.9925***	0.019	0.480***

Levels of significance: * = 5%, ** = 1%, *** = 0.1%

Table 8

The percentage difference between measured and calculated values of the different characteristics at 1 m²

	Spring			Summer			Autumn		
	N_i	C_i	B_{Li}	N_i	C_i	B_{Li}	N_i	C_i	B_{Li}
Festuca	0.5	11.6	−2.3	−3.1	−3.5	−1.1	−1.7	−3.2	−1.9
Thymus	−11.4	−5.4	−2.3	5.3	5.1	0.0	2.7	−1.2	5.1
Fumana	−8.6	−8.9	−2.9	−11.0	−14.6	−9.9	−5.1	13.4	−7.0
Carex	2.4	17.9	23.4	−0.4	−0.4	6.7	−5.9	−5.9	−8.0
Arenaria	13.3	13.5	6.9	—	—	—	—	—	—
Medicago	—	—	—	—	—	—	−3.2	−3.2	−2.2

Negative values represent underestimation of the measured values, positive values are overestimations

The intersection of regression curves and the exceptions mentioned at the seasonal changes (cf. *2.1*) refer to this fact, too. Assuming this we shall deal with the problem of species patterns in the next paper.

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(Further references can be found in Part I.)

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PRODUCTIVITY AND PHOTOSYNTHETIC FLEXIBILITY IN SOME SPECIES OF A GRASSLAND COMMUNITY*

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The CO_2 assimilation type of 48 species in the sand steppe community of the Kis-Tece grassland (Vácrátót, near Budapest) was examined in different seasons, after wet and dry periods, during about four years (1976—1979). Of the 48 species examined, on the basis of enzyme activity ratios, one species (*Cynodon dactylon*) was found to be of C_4 assimilation type in the spring period (end of May). Several of the species, on the basis of their high PEP-carboxylase activity were grouped as so-called intermediary types. After a dry summer period, there occurred only 30 species of the community which were in a state suitable for examination. Primarily the RuBP-carboxylase activity decreased to a very great extent in a majority of these, too. Several of the species categorised as of intermediary types kept their PEP-carboxylase activity at a high level, making thereby probable their shift into the C_4 assimilation. type. Among these emphasis can be put to *Carex praecox*, *Festuca vaginata*, *F. wagneri*, *Koeleria majoriflora* and *Phleum phleoides*.

Introduction

The biochemical variants of photosynthetic CO_2 assimilations in the circle of higher plants were studied from several approaches in the past ten years. The experimental method of studying and separating the variants is, after $^{14}CO_2$ assimilation, the exploration of qualitative patterns and the characteristics of enzyme systems catalysing the reactions. The CO_2 assimilation pathway which was recognised and described first is the Calvin cycle, which is also named in the specialised literature as photosynthetic carbon-reducing cycle, or, recently, as C_3 pathway as well (CALVIN and BASSHAM 1962). In another group of species, the primary fixation of CO_2, thus the primary products and the intermediaries are different from those of the former species group. This is the so-called C_4 pathway or C_4-type CO_2 assimilation (KORTSCHAK et al. 1965). However, the terminal step is the CALVIN cycle in these species, too.

In the third group of species, CO_2 becomes fixed in the dark cycle and is stored in the form of malic acid. This is the so-called *Crassulaceae* acid metabolism (CAM). The transformation of CO_2 into carbonhydrate, however, takes place also in the latter case, through the CALVIN cycle, the light cycle. Thus the reactions and enzymes of the CALVIN cycle are general in the whole plant world. The CO_2 assimilation differences are dependent of how the CO_2 originating from outside resources comes into connexion with the carboxylase reaction. This preceding mechanism, however, significantly influences the photosynthetic effectiveness measurable by the carbonhydrate product. Under identical ecological conditions, but primarily in arid climate, C_4-type plants can be characterised as having high photosynthetic and growth rates, and low photorespiration values (HATCH et al. 1969; HATCH and SLACK 1970). The

* Tece studies No. 22.

regulative role of CO_2 fixation, preceding the CALVIN cycle, is testified by that CO_2 assimilation in C_4-type plants can be strongly reduced by the inhibition of PEP-carboxylase (OSMOND and AVADHANI 1970).

Thus, in these plants, there is no way of CO_2 fixation to a significant extent by avoiding the C_4 cycle. The PEP-carboxylase activity is of decisive importance from the viewpoint of the function of the cycle preceding the CALVIN cycle. This is served in C_4-type plants by the allozyme form, which is different in its kinetic characteristics from that of C_3-type plants (TING and OSMOND 1973).

By taking into consideration that in the net organic matter production the function of the CALVIN cycle is in the last analysis decisive, and that at the same time its functionability is served by the C_4-cycle we can characterise the co-ordinated possibilities of the two pathways under different ecological conditions by the activity of the two carboxylase enzymes. Our earlier measurements were carried out on this basis (HORÁNSZKY and NAGY 1977), and as a continuation of that, the present work provides comparative data and inferences related to arid and moisterous climatic periods in the growth of several species.

Materials and methods

The plant materials were collected in the end of May and beginning of June 1978, in a strongly moistaneous period, and in the beginning of July, 1979, following an extremely rainless, arid period. In the latter sampling not all the species that had been examined earlier were taken into consideration; the missing species were no longer in a green state showing photosynthetic activity in the arid period.

Leaf specimens of measured weight were homogenised in HEPES puffer (pH 6.5), volume ratio 10x (v/w), 0.02 M, containing 1% of Tween 80 and 1% of PVP 40 which keeps the native character of the isolated and the unfixed protein even in the case of leaves with high polyphenol content (GEZELIUS 1975).

The security of the sulfhydryl groups was ensured by the 0.05 M 2-mercapto-ethanol and 0.05 M dithiotreitol. The extracts were separated in a JANETZKI K70 cooling centrifuge by 4500 xg and the supernatants, were used for measuring the enzyme activities.

The RuBP and PEP-carboxylase activities were determined on the basis of the $H^{14}CO_3$ incorporation technique described in the publication of NAGY et al. (1973). The values of measurements were calculated for specimens of identical fresh weight, as — owing to the numerous disturbing components — a reliable measurement of the protein content was not possible.

Results

The PEP-carboxylase activities, and the values of RuBP/PEP-carboxylase ratio obtained from the specimens taken in the early summer moisterous cool period of 1978 are shown in the first column of Table 1. In the same Table the enzyme activity of the species still available after the arid period as well as the activity ratios of key enzymes are also shown. It clearly seems from the data that in the case of species still surviving after the arid period in a form which ensures functionability, the enzyme activities decreased to a great extent in comparison with those in the period of more favourable water supply, and that the ratio of the two enzymes also changed considerably.

For inferences related to the production it seemed reasonable to make a comparison between the activity ratios that can be measured in the enzymes

Table 1

Activity of carboxylase enzymes in species of a sand steppe community, after a wet period (I), and after an arid period (II)

Species	PEP-c μmol CO_2/g · h	RuBP-c / PEP-c	PEP-c μmol CO_2/g · h	RuBP-c / PEP-c
Achillea collina	0.91	1.68	0.04	0.61
Achillea ochroleuca	0.38	8.85	0.17	0.22
Andropogon ischaemum	1.41	1.92	0.08	0.67
Anthemis ruthenica	0.09	14.63	0.06	0.37
Arenaria serpyllifolia	0.61	2.07	—	—
Asparagus officinalis	—	—	0.16	0.24
Bromus mollis	0.90	2.51	—	—
Bromus tectorum	0.63	2.60	—	—
Carex praecox	1.29	3.11	0.39	0.34
Carex stenophylla	4.07	3.30	—	—
Carex wohllebii	0.98	2.61	—	—
Cerastium viscosum	0.40	1.78	—	—
Centaurea arenaria	0.39	12.52	—	—
Crepis rhoeadifolia	0.08	13.83	0.03	2.46
Cynodon dactylon	9.36	0.18	0.18	0.17
Cynoglossum hungaricum	0.07	19.46	0.03	0.68
Equisetum ramosissimum	0.50	6.81	0.11	0.30
Erigeron canadensis	0.24	8.82	0.07	0.83
Eryngium campestre	0.61	4.19	0.17	0.66
Erysimum canescens	0.49	6.87	0.08	0.32
Euphorbia seguieriana	0.66	9.78	0.45	1.62
Festuca vaginata	0.65	3.14	0.37	0.05
Festuca wagneri	0.63	3.37	0.30	0.05
Fumana procumbens	0.13	1.36	0.03	0.64
Holoschoenus romanus	0.74	4.96	0.10	0.41
Koeleria majoriflora	0.43	5.48	0.21	0.29
Medicago minima (falcata)	0.37	11.50	(0.02)	(7.53)
Minuartia verna	0.27	8.32	—	—
Myosotis arvensis	0.25	2.90	—	—
Onosma arenarium	0.17	7.94	0.03	0.93
Phleum phleoides	0.41	66.42	0.19	0.16
Poa angustifolia	0.98	2.86	0.27	0.26
Potentilla arenaria	0.12	14.59	0.06	0.63
Potentilla impolita	0.13	10.01	0.05	0.56
Reseda lutea	—	—	0.06	3.84
Scleranthus annuus	9.54	1.13	—	—

Table 1 (cont.)

Species	PEP-c μmol CO_2/g · h	RuBP-c / PEP-c	PEP-c μmol CO_2/g · h	RuBP-c / PEP-c
Secale silvestre	0.61	3.77	—	—
Sedum sexangulare	0.11	5.55	0.06	0.27
Silene conica	0.25	2.00	—	—
Stipa sabulosa	6.07	1.35	0.29	0.15
Sisymbrium altissimum	0.22	20.19	0.05	4.65
Teucrium chamaedrys	0.31	5.26	—	—
Thymus sp.	0.28	6.10	0.02	2.31
Trifolium arvense	0.68	6.56	—	—
Trifolium aureum	0.89	5.58	—	—
Vicia lathyroides	0.64	6.12	—	—
Vicia tetrasperma	0.63	7.73	—	—

of the species in the wet and in the arid periods. The data are given in Table 2. It is unambiguously clear from the Table that in the case of all the species examined the activity of RuBP carboxylase shows a decrease of essentially greater extent than that of the other carboxylase enzyme. In the case of certain species — e.g. *Festuca vaginata*, *F. wagneri*, *Erysimum canescens*, *Equisetum ramosissimum*, *Cynodon dactylon* — under wet climatic conditions, RuBP-carboxylase may even be of hundred times higher activity. The level of enzyme activities after the dry period, shows in itself an interesting pattern as is clear from the further part of Table 2. The species can be categorised from this point of view into three groups:

a) *both enzymes are present with relative by high activity, in a functionable form* (*HH*);

b) *both enzymes show a low activity level, which may be consequence of either a constitutive character or a degeneration following the arid period* (*LL*);

c) *one or the other carboxylase enzyme activity remains of a high level even under arid climatic conditions* (*HL or LH*).

Discussion

By taking the various known pathways of photosynthetic CO_2 assimilation as a point of departure, and on the basis of relations (and changes in these relations) in respect of the activity of carboxylase enzyme which plays a key role in the two carboxylase reactions, we studied the functional dynamics of a sand steppe community, under changing climatic conditions. Whether a plant is capable of organic matter production is decided independently of its

Table 2

Ratio of the activity in carboxylase enzymes in the samples taken after wet resp. dry periods; levels of activity after the arid period

Species	Activity ratio wet/arid		Activity level	
	RuBP-c	PEP-c	RuBP-c	PEP-c
Achillea ochroleuca	84.05	2.24	L	L
Anthemis ruthenica	67.50	1.50	L	L
Carex praecox	29.90	3.31	H	H
Crepis rhoeadifolia	15.26	2.67	L	L
Cynodon dactylon	131.40	52.00	L	H
Cynoglossum hungaricum	72.75	2.33	L	L
Equisetum ramosissimum	101.69	4.55	L	L
Erigeron canadensis	37.15	3.43	L	L
Eryngium campestre	23.32	3.59	H	L
Erysimum canescens	133.35	6.13	L	L
Euphorbia seguieriana	88.79	1.47	L	L
Festuca vaginata	102.05	1.76	L	H
Festuca wagneri	106.00	2.10	L	H
Holoschoenus romanus	85.49	7.40	L	L
Koeleria majoriflora	40.02	2.05	L	H
Onosma arenarium	41.62	5.67	L	L
Phleum phleoides	84.40	2.16	L	H
Poa angustifolia	39.47	3.63	L	H
Potentilla arenaria	51.48	2.60	L	L
Potentilla impolita	47.45	2.60	L	L
Sedum sexangulare	37.79	1.50	L	L
Stipa sabulosa	187.69	20.93	L	H
Sisymbrium altissimum	18.80	4.40	H	L

CO_2 assimilation type, by the functionability of the CALVIN cycle, i.e. the functionable presence of e.g. the RuBP-carboxylase enzymes (HATCH 1976). In our esperimental area, in the early summer period, when a statisfactory quantity of rain is ensured, the RuBP-carboxylase activity of the plant species in all the species examined surpassed that of the PEP-carboxylase. Even under such conditions (favourable water supply), *Cynodon dactylon* is of in a C_4-type, with extremely high PEP-carboxylase activity. In the case of the other species also, the high level of PEP-carboxylase activity indicates the type of assimilation, which is accompanied by a 1.0—3.0 times higher RuBP-carboxylase activity In our earlier examinations these species were characterized as transitional types, on the basis of the work by KENNEDY and LEATSCH

(1974). The experimental results presented in this paper indicate that the favourable climatic conditions primarily promote the possibilities of the CALVIN cycle's functioning, e.g. by ensuring a higher level of RuBP-carboxylase enzyme activity. DOLINER and JOLIFFE (1979) found competition between C_3 and C_4 species only under the conditions of low moisture quantity and high temperature. From this we drew the conclusion that the C_4 species became specialised, from ecological view points, to a higher extent than did the C_3 species. EICKMEIER (1978), by examining the species along an aridity gradient by their CO_2 assimilation types, states that the C_4 species appear with an increased importance in the community only under arid climatic conditions. The species dominant with the increase in the moisture content are of a C_3 type.

On the basis of the results of our experiments we can infer that the so-called intermediary type plants, having a high level of PEP-carboxylase, possess an adaptive superiority under such conditions where it is not the gradient of moisture supply, but when the alternations of moisturous and extremely arid periods succeed each other in the same area. In the periods with favourable water supply, RuBP-carboxylase and probably together with it the CALVIN cycle operates with high intensity. The conditions of this can be ensured by a measured level of the C_4 dicarbonic acid cycle. The unfavourable, arid climatic conditions primarily influence the RuBP-carboxylase activity, and decrease the effectivity. It is remarkable that the PEP-carboxylase is considerably less sensitive to the change in water supply.

From the viewpoint of organic matter production, we should, however, emphasise those species in which still relatively high enzyme activity levels could be measured even under arid conditions. Of the plants examined, in *Sysimbrium altissimum* and *Eryngium campestre* the characteristic C_3-type CO_2 assimilation persists, and the enzyme of RuBP-carboxylase is outstandingly stable. *Carex praecox* shows a C_4-type under changed climatic conditions, but the activity of both enzymes remains at a high level, therefore its role in this respect is important in the permanent organic matter production of the grassland community. The two *Festuca* species and the *Koeleria majoriflora*, the *Phleum phleoides* and the *Cynodon* show a C_4 assimilation type, with high PEP-carboxylase activity. In the latter species, a further utilisation of the CO_2 which has been fixed in the C_4 cycle depends on how the still existing capacity of the CALVIN cycle ensures the continuation of development.

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SHORT-TERM STUDIES ON THE PHYTOPLANKTON OF LAKE BALATON IN THE SUMMERS OF 1976, 1977 AND 1978

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The author studied the phytoplankton of Lake Balaton at Tihany by means of daily sampling for one month in the summers of 1976, 1977 and 1978, respectively. There was considerable daily variation in the number of algae. Number of species and abundance of members of the phyla *Cyanophyta* and *Chlorophyta* increased over the three years. Chlorophyll-a content showed closer correlation with seston content than with the number of algae. The study relates some phenomena connected with the eutrophication of Lake Balaton, and points out the phasic nature of seasonal succession and discusses some effects of the wind on the shallow lake.

Introduction

Recently, short-term algological studies based on daily sampling have been launched on Lake Balaton, the largest shallow lake in Central Europe (G.-TÓTH and PADISÁK 1978). The quantitative aspects of the phytoplankton of the Lake are otherwise well known (SEBESTYÉN et al. 1951; SEBESTYÉN 1953; TAMÁS 1955, 1957, 1969, 1972, 1974, 1975). The lake has a surface area of 596 m², a length of 77.9 km, it is 7.7 km wide and on the average 3.14 m deep.

I studied the changes in number and biomass of the total phytoplankton for a month in the summers of 1976, 1977 and 1978, respectively. In the last year, changes in the seston and chlorophyll-a content of the water were also measured and the changes in *pigment extinction rate* (from now: PER; HAJDÚ et al. 1980) were calculated.

During the study, one of my goals was to describe the exact dynamics of the abovementioned variables and to study some of their interrelations. My other objective was to collect date and conclusions for the Balaton Eutrophication Model (CSÁKY 1979a, 1979b; HERODEK et al. 1979) which was based on sampling at larger intervals.

Collection, material and methods

Water samples were collected daily for one month with Friedinger sampler between 20 July and 18 August in the years 1976 and 1977, and between 26 July and 24 August in 1978. Samples were collected between 10 and 12 a.m. from four layers (20, 100, 200 and 300 cm) at each of five points around an open water buoy about 800 m from the waterfront of the Biological Research Institute at Tihany (Fig. 1). The samples thus collected from 20 places (5 points, 4 layers per point) were mixed and subsamples were drawn from the mixture. For quantitative examination algae were fixed with Lugol solution and the bottles were kept in the dark till processing.

The chlrophyll-a content of the water was determined according to FELFÖLDY (1972a) always on the same day when the sample was collected. Sartorius glassfiber filters (13,400) were used. The filtering with water suction pump was carried out till the passage of water slowed down due to the particles blocking the pores of the filter. Minimum amount of water filtered was 600 ml (in storm), maximum was 3500 ml. I did not use alum solution and $MgCO_3$ suspension at filtering. Pigments were extracted with methanol and the decanted extracts

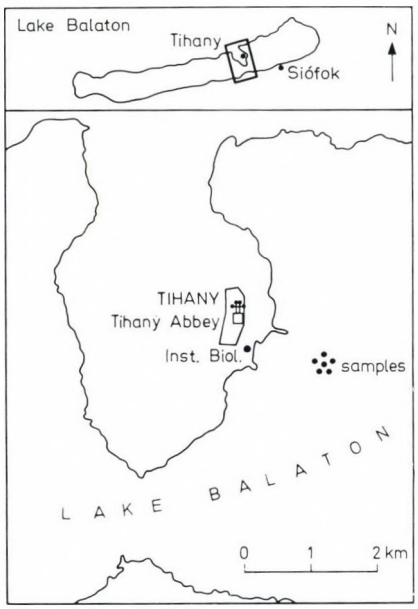

Fig. 1. Location of sampling points

were centrifuged at 3500 rpm for 10 min. PER was computed according to the formula $PER = \frac{E_{480}}{E_{666}}$ which is identical to MARGALEF's (1968) pigment diversity.

To determine the seston content, water was filtered through Sartorius Membranfilter (pore size: 0.45 μm) till no appreciable passage was observed. The membrane filter weighed previously was then dried to constant weight in a closed chamber. The weighing was repeated before the calculation of the seston content.

Algae were counted with inverted microscope (UTERMÖHL 1958) as follows:

— at 128× magnification the large algae were counted on the whole surface area of the sedimentation chamber (10 ml in volume); these measured a minimum of 70 μm in length and a minimum of 30 μm in width,

— at 400× magnification the smaller algae were counted in each five of 200 μm wide strips along the whole length of sedimentation chamber: these were smaller than the previous group, but — larger than 10 μm. (Algae smaller than 10 μm cannot be correctly estimated for Lake Balaton by means of UTERMÖHL's microscope, due to interference by inorganic detritus in the sample. This problem is treated elsewhere (G.-TÓTH and PADISÁK 1978, G.-TÓTH 1980).

Each counting was carried out to about 400 individuals, thus incurring a bials of about 10% (LUND et al. 1958). Biomass values were computed by calculating the volume of the algae and taking the specific gravity of the protoplasm a 1.00. Calculations of volumes were based on my own data and on SEBESTYÉN's (1954) data for dinoflagellates. Table 2 is a summary of the volumes calculated.

The eutrophic bioindicators, suggested by some Hungarian authors (FELFÖLDY 1972b; BARTHA et al. 1976; KOVÁCS 1976; FELFÖLDY 1977) are indicated with an asterisk in Table 2.

Results

169 species, varietas and forms were identified in the 90 samples, which were distributed among the following taxons:

Cyanophyta		
Chroococcales	12	taxa
Hormogonales	14	,,
Euglenophyta		
Euglenales	8	,,
Pyrrophyta		
Cryptophyceae	4	,,
Dinophyceae	3	,,
Chrysophyta		
Xanthophyceae	1	,,
Chrysophyceae	3	,,
Bacillariophyceae	42	,,
Chlorophyta		
Volvocales	3	,,
Tetrasporales	2	,,
Chlorococcales	66	,,
Desmideaceae	10	,,
Other sp.	1	,,
Total	169	taxa

Changes in number or biomass of phytoplankton over periods of one month are not clearly of decreasing or increasing trends (Table 1). There is a marked daily fluctuation in both variables in all three years.

The abundance of phylum *Chrysophyta* greatly decreased in 1976 after a peak at the beginning of the period. Similar, though less pronounced trends were observed in the other years. The decrease in mean numbers from 1976 to 1978 is significant at $p = 0.1\%$ (Sváb 1973).

Neither was there a clear decrease or increase in number of phylum *Euglenophyta* over the periods of 30 days. It is remarkable, however, that cyclic high and low values were observed at 7 to 10 days intervals in all 30-day periods.

There was decrease in mean numbers among members of the phyla *Chrysophyta*, *Euglenophyta* and *Pyrrophyta* over the 3 years. In contrast with other two phyla of this group, biomass of *Pyrrophyta* did not decrease, since it was great determined by *Ceratium hirundinella*, which did not decrease or increase appreciably in numbers.

Mean number and biomass of members of the phyla *Cyanophyta* and *Chlorophyta* significantly increased over three years. The former increased at $p = 0.1\%$ level of significance, the latter at $5\% < p < 10\%$ level.

Different changes in numbers of various alga phyla influenced the changes in mean total number over three years. High mean total numbers in 1976 were primarily due to the chrysophytes. In 1977 the proportion of chrysophytes decreased and cyanophytes increased in number. By 1978 the number

Table 1 *Changes in number of individuals ($i \cdot l^{-1}$) and biomass ($mg \cdot l^{-1}$) Cyanophyta*

	1976		1977		1978	
	ind · l^{-1}	mg · l^{-1}	ind · l^{-1}	mg · l^{-1}	ind · l^{-1}	mg · l^{-}
20 July	297,000	0.01	129,600	0.16		
21	192,375	0.01	91,125	0.06		
22	121,500	0.01	138,712	0.14		
23	281,130	0.02	152,888	0.10		
24	303,750	0.01	387,788	0.29		
25	324,000	0.05	351,343	0.35		
26	189,000	0.01	198,450	0.18	530,550	0.84
27	135,000	0.01	229,888	0.18	696,600	0.88
28	212,625	0.36	400,950	0.40	447,525	0.60
29	222,500	0.10	342,326	0.37	370,575	0.40
30	87,750	0.09	258,188	0.23	409,050	0.46
31	167,060	0.12	314,888	0.28	562,950	0.67
1 August	148,500	0.24	299,700	0.22	415,125	0.43
2	229,500	0.25	383,500	0.16	330,075	0.35
3	197,440	0.26	305,775	0.25	362,475	0.39
4	118,966	0.06	256,163	0.18	558,900	0.75
5	141,750	0.10	357,463	0.28	275,400	0.27
6	209,250	0.04	329,063	0.18	423,225	0.45
7	302,180	0.54	281,475	0.15	506,250	0.44
8	236,900	0.20	370,575	0.26	486,000	0.53
9	205,815	0.20	367,538	0.21	368,550	0.23
10	140,310	0.25	208,575	0.11	1,055,025	1.46
11	178,875	0.18	334,125	0.15	1,316,250	1.94
12	158,625	0.13	261,225	0.12	771,525	1.11
13	354,500	0.15	333,113	0.18	1,038,825	1.42
14	209,160	0.22	275,775	0.27	911,250	1.07
15	213,666	0.27	283,500	0.20	990,225	1.39
16	266,360	0.28	573,075	0.35	1,026,675	1.24
17	155,250	0.13	573,075	0.50	1,079,325	1.31
18	57,375	0.02	563,963	0.45	992,250	1.40
19					1,342,575	1.86
20					1,413,450	1.69
21					1,273,725	1.63
22					1,595,700	1.96
23					1,182,600	1.26
24					1,391,175	1.51
Average	201,937	0.16	306,192	0.23	804,128	1.00

of the phytoplankton at Tihany over the three study periods, by the phyla and pooled

Euglenophyta

	1976		1977		1978	
	ind · l^{-1}	mg · l^{-1}	ind · l^{-1}	mg · l^{-1}	ind · l^{-1}	mg · l^{-1}
20 July	23,627	0.09	6,975	0.02		
21	111,260	0.70	27,025	0.09		
22	101,230	0.59	6,475	0.03		
23	30,365	0.19	14,775	0.06		
24	41,700	0.36	23,988	0.09		
25	1,396	0.01	17,313	0.06		
26	1,290	0.01	8,200	0.03	8,200	0.02
27	15,100	0.13	35,425	0.12	8,300	0.02
28	21,250	0.18	19,938	0.07	12,250	0.04
29	29,200	0.25	17,705	0.06	4,050	0.01
30	52,125	0.45	18,825	0.06	8,200	0.03
31	11,325	0.09	27,638	0.09	18,625	0.06
1 August	21,550	0.18	15,688	0.06	6,275	0.02
2	31,878	0.27	25,713	0.10	10,125	0.03
3	21,650	0.12	37,863	0.13	6,475	0.03
4	21,050	0.15	5,625	0.02	10,125	0.03
5	20,950	0.18	20,250	0.06	12,650	0.05
6	34,000	0.29	9,913	0.04	14,575	0.05
7	52,230	0.45	12,150	0.04	4,250	0.01
8	16,800	0.15	12,850	0.05	6,350	0.02
9	22,450	0.19	6,375	0.02	8,300	0.02
10	14,300	0.12	9,513	0.03	14,475	0.03
11	10,938	0.09	17,413	0.07	6,275	0.02
12	9,038	0.08	6,175	0.02	4,150	0.01
13	46,790	0.09	27,213	0.11	10,425	0.04
14	74,010	0.54	24,975	0.10	12,650	0.04
15	7,130	0.06	4,650	0.01	8,500	0.03
16	15,875	0.11	4,450	0.02	12,125	0.03
17	7,115	0.04	38,563	0.01	100	0.02
18	5,575	0.01	8,800	0.03	13,125	0.04
19					20,350	0.07
20					28,750	0.08
21					8,400	0.03
22					18,325	0.05
23					26,625	0.07
24					28,450	0.08
Average	29,107	0.17	17,082	0.06	11,717	0.06

Table 1 (continued)

Pyrrophyta

	1976		1977		1978	
	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹
20 July	28,325	0.28	20,125	0.55		
21	66,550	0.40	19,188	0.25		
22	96,425	0.58	24,000	0.46		
23	26,150	0.39	43,050	0.85		
24	22,250	0.13	96,725	0.96		
25	128,650	0.61	61,975	0.94		
26	48,650	0.87	8,625	0.35	28,375	0.54
27	95,550	0.92	22,963	0.55	13,100	0.28
28	125,725	0.62	21,675	0.43	10,575	0.25
29	91,000	0.69	20,025	0.56	18,675	0.95
30	184,375	1.35	30,450	1.00	14,900	0.79
31	161,400	0.71	31,725	0.79	21,875	0.85
1 August	280,380	0.98	19,375	0.33	18,825	0.90
2	177,250	1.46	17,125	0.41	74,300	1.02
3	210,375	1.06	18,025	0.43	35,175	1.14
4	167,340	0.82	6,600	0.35	20,675	0.38
5	175,560	0.70	7,200	0.38	10,825	0.48
6	40,530	0.25	18,000	0.56	42,400	1.00
7	152,000	0.54	13,700	0.73	11,828	0.53
8	120,860	0.87	10,800	0.57	28,225	1.38
9	87,950	0.83	13,525	0.63	27,175	0.72
10	77,560	0.49	6,700	0.35	44,850	0.51
11	104,700	0.89	12,650	0.47	27,675	0.74
12	42,423	0.31	6,600	0.36	17,750	0.32
13	78,620	0.91	8,200	0.42	20,550	0.46
14	157,220	1.04	12,950	0.47	46,950	1.45
15	57,040	0.52	9,475	0.20	22,000	0.33
16	75,350	1.08	5,200	0.27	14,925	0.69
17	78,080	0.65	13,350	0.50	14,500	0.35
18	19,575	0.14	13,650	0.51	23,725	0.33
19					16,275	0.55
20					22,650	0.57
21					20,575	0.37
22					11,275	0.28
23					14,225	0.24
24					40,475	1.00
Average	105,929	0.67	20,455	0.52	24,511	0.65

Table 1 (continued)

Chrysophyta

	1976		1977		1978	
	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹
20 July	361,225	0.18	200,163	0.24		
21	1,223,425	0.91	302,346	0.74		
22	1,245,775	0.50	261,788	0.62		
23	1,024,430	0.69	287,313	0.61		
24	1,622,200	0.88	421,977	0.75		
25	1,623,650	1.98	279,742	0.55		
26	1,015,100	0.59	545,163	0.97	146,000	0.21
27	1,116,650	0.78	552,246	0.90	200,575	0.29
28	755,050	0.46	442,426	0.58	107,525	0.17
29	1,597,900	1.18	218,488	0.42	111,475	0.11
30	1,002,900	0.73	256,763	0.57	161,675	0.43
31	877,317	0.50	404,876	0.65	286,625	0.47
1 August	1,312,200	0.96	458,626	0.93	174,850	0.22
2	963,460	0.93	531,726	0.90	575,150	0.90
3	810,767	0.81	234,526	0.70	255,650	0.31
4	698,040	0.70	263,788	0.67	186,700	0.26
5	709,175	0.67	499.850	1.40	216,750	0.37
6	678,950	0.54	260,400	0.45	295,725	0.36
7	586,590	0.50	141,238	0.26	122,300	0.17
8	428,275	0.36	162,500	0.33	293,775	0.48
9	326,725	0.32	138,400	0.34	202,950	0.57
10	179,305	0.17	158,326	0.51	384,900	0.60
11	344,023	0.24	273,838	0.81	348,675	0.60
12	246,375	0.19	157,025	0.39	237,825	0.34
13	406,500	0.53	210,451	0.60	368,925	0.57
14	348,483	0.44	207,825	0.39	299,750	0.72
15	323,150	0.69	299,439	0.69	177,675	0.40
16	417,055	0.65	184,025	0.47	134,350	0.27
17	629,840	0.73	405,713	0.95	154,500	0.26
18	301,280	0.31	372,063	0.71	203,800	0.51
19					181,425	0.35
20					181,225	0.31
21					226,075	0.38
22					168,775	0.29
23					247,350	0.32
24					186,500	0.33
Average	772,526	0.60	304,436	0.64	227,983	0.39

Table 1 (continued)

Chlorophyta

	1976		1977		1978	
	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹
20 July	135,000	0.22	231,650	0.13		
21	141,750	0.26	111,157	0.07		
22	135,100	0.19	202,001	0.15		
23	71,075	0.09	232,263	0.16		
24	182,950	0.21	399,726	0.20		
25	243,500	0.15	334,220	0.21		
26	108,700	0.12	218,888	0.20	231,551	0.18
27	264,125	0.12	261,214	0.17	331,988	0.27
28	200,200	0.14	363,876	0.24	230,938	0.16
29	225,300	0.10	239,551	0.26	200,875	0.16
30	221,240	0.08	264,051	0.22	166,510	0.10
31	138,919	0.06	136,827	0.15	269,313	0.18
1 August	147,063	0.08	218,676	0.18	220,100	0.15
2	89,400	0.03	258,676	0.15	217,163	0.27
3	140,672	0.06	169,802	0.14	219,400	0.18
4	122,210	0.07	163,200	0.17	215,250	0.18
5	139,730	0.04	177,376	0.16	146,900	0.10
6	164,200	0.09	259,588	0.23	232,050	0.15
7	225,750	0.14	146,176	0.15	235,800	0.17
8	160,955	0.13	166,238	0.82	185,275	0.24
9	117,196	0.04	181,113	0.16	139,413	0.11
10	106,785	0.04	101,339	0.08	337,050	0.28
11	121,170	0.08	296,140	0.21	508,963	0.40
12	148,010	0.06	278,868	0.14	438,313	0.40
13	102,790	0.04	328,525	0.16	503,300	0.37
14	120,218	0.05	153,075	0.09	372,788	0.33
15	98,060	0.05	127,863	0.09	477,988	0.33
16	164,800	0.05	211,488	0.15	278,525	0.26
17	192,375	0.07	248,725	0.25	380,775	0.25
18	67,055	0.03	311,326	0.27	373,800	0.39
19					258,550	0.18
20					389,275	0.31
21					265,975	0.23
22					292,900	0.28
23					255,225	0.22
24					172,525	0.15
Average	149,877	0.11	226,454	0.19	284,949	0.23

Table 1

Total algae

	1976		1977		1978	
	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹	ind · l⁻¹	mg · l⁻¹
20 July	845,177	0.74	588,513	1.10		
21	1,735,360	2.38	550,841	1.22		
22	1,700,030	1,87	632,976	1.39		
23	1,430,020	1.39	730,289	1.78		
24	2,172,850	2.04	1,130,204	2.30		
25	2,321,296	2.87	1,044,593	2.13		
26	1,362,740	1.64	979,366	1.72	944,675	1.79
27	1,626,425	1.77	1,101,726	1.91	1,250,563	1.75
28	1,314,850	1.43	1,248,865	1.73	808,813	1.22
29	2,165,900	2.26	838,095	1.66	705,650	1.64
30	1,548,390	2.64	828,277	2.08	760,275	1.81
31	1,356,021	1.37	915,954	1.96	1,159,388	2.23
1 August	1,909,693	2.30	1,012,065	1.72	834,575	1.71
2	1,491,128	2.73	1,116,740	1.71	1,206,813	2.57
3	1,380,904	1.78	765,991	1.65	879,125	2.05
4	1,127,606	1.80	695,376	1.39	991,650	1.61
5	1,187,165	1.60	1,062,139	2.29	662,525	1.26
6	1,126,930	1.18	576,964	1.46	1,007,975	2.01
7	1,318,750	1.68	593,739	1.33	880,425	1.31
8	963,760	1.96	722,963	1.29	999,650	2.65
9	760,136	1.46	706,951	1.35	746,388	1.64
10	518,260	0.89	484,452	1.09	1,836,300	2.88
11	759,706	1.32	934,067	1.70	2,207,838	3.70
12	604,471	0.82	709,993	1.02	1,469,563	2.18
13	989,200	1.92	907,502	1.48	1,941,725	2.86
14	909,091	2.11	674,600	1.32	1,643,388	3.61
15	699,586	1.38	724,927	1.19	1,676,388	2.50
16	939,440	2.00	810,163	1.26	1,466,600	2.47
17	1,062,660	1.29	1,279,426	2.31	1,629,200	2.18
18	450,860	0.65	1,269,802	1.97	1,606,700	2.67
19					1,819,175	3.02
20					2,035,350	2.96
21					1,794,950	2.64
22					2,086,975	2.86
23					1,726,025	2.11
24					1,819,125	3.09
Average	1,259,277	1.71	861,252	1.62	1,353,261	2.27

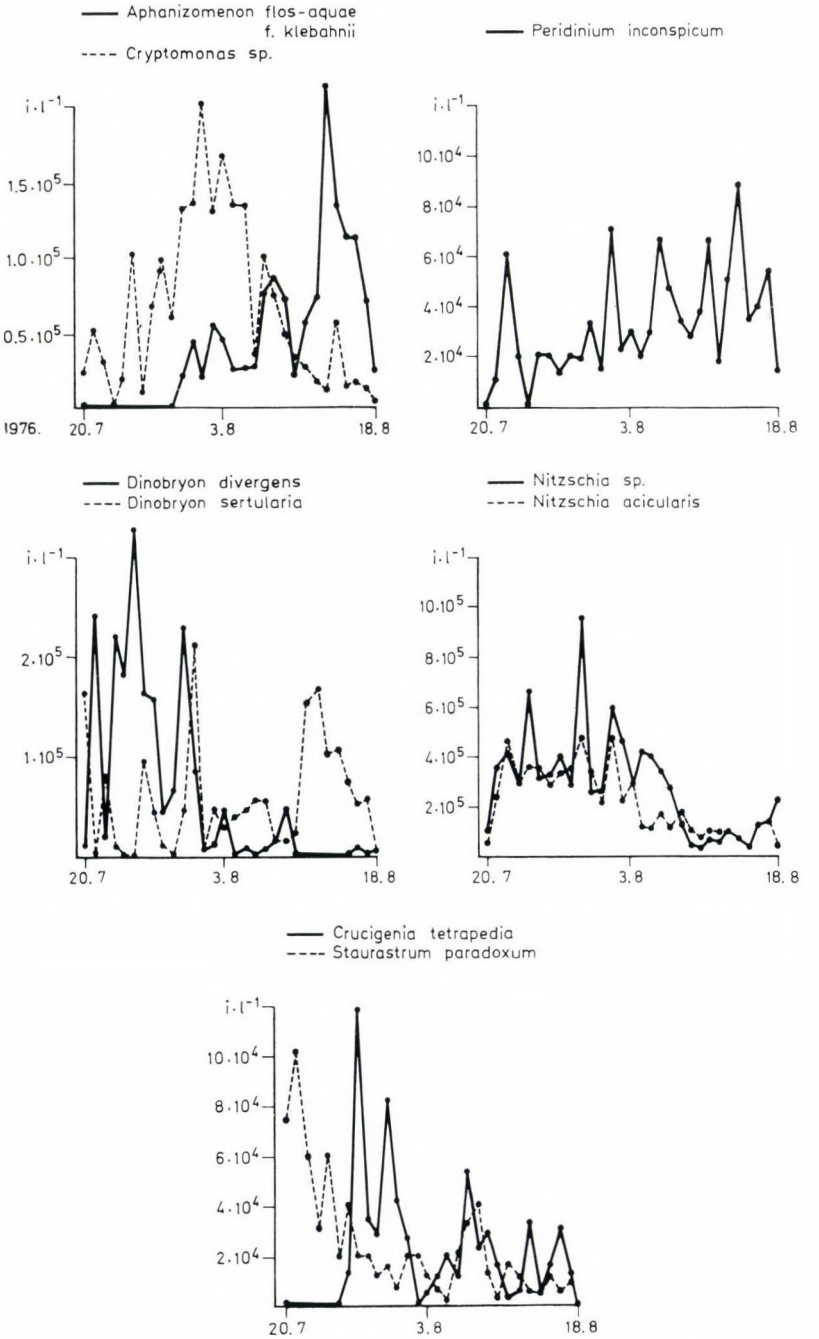

Fig. 2. Population dynamics of some species between 20 July and 18 August, 1976, which are numerically important in the phytoplankton community

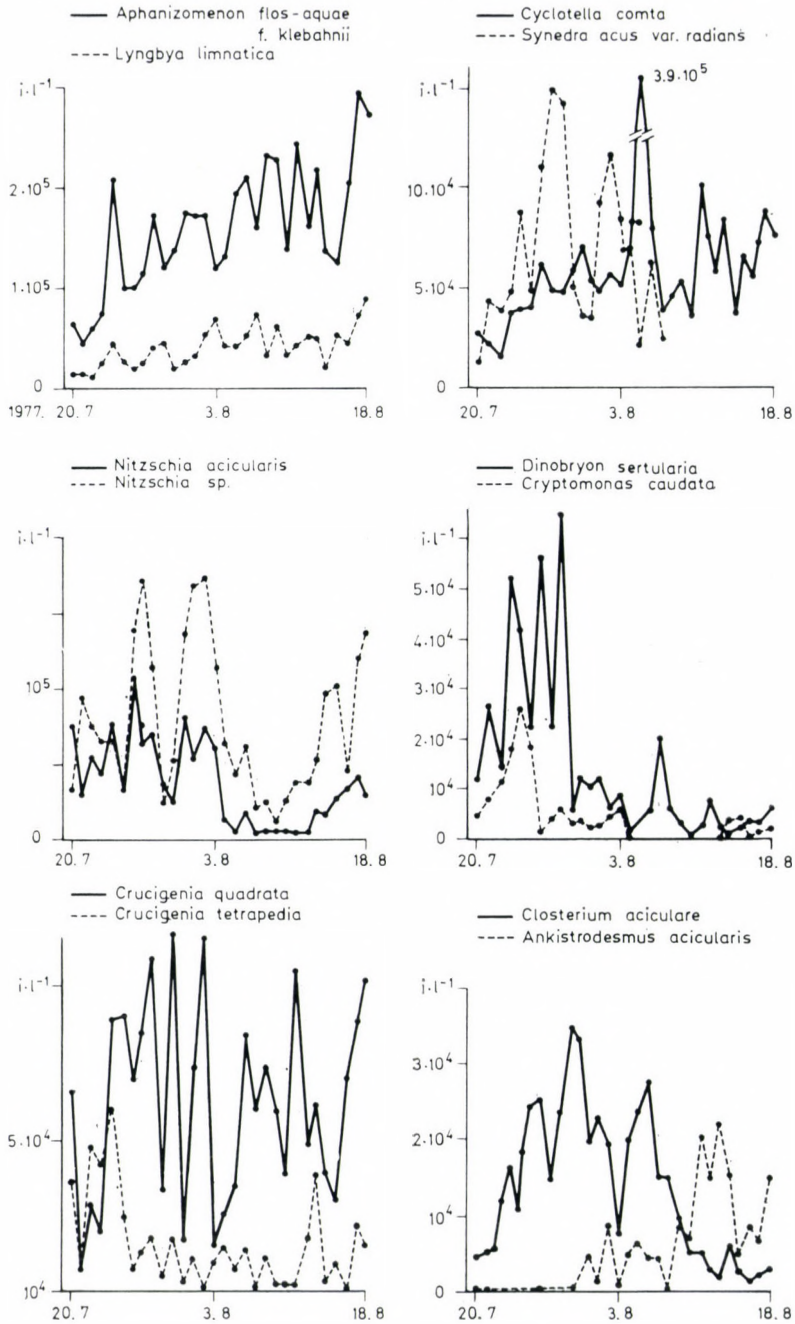

Fig. 3. **Population dynamics of some species between 20 July and 18 August, 1977, which are numerically important in the phytoplankton community**

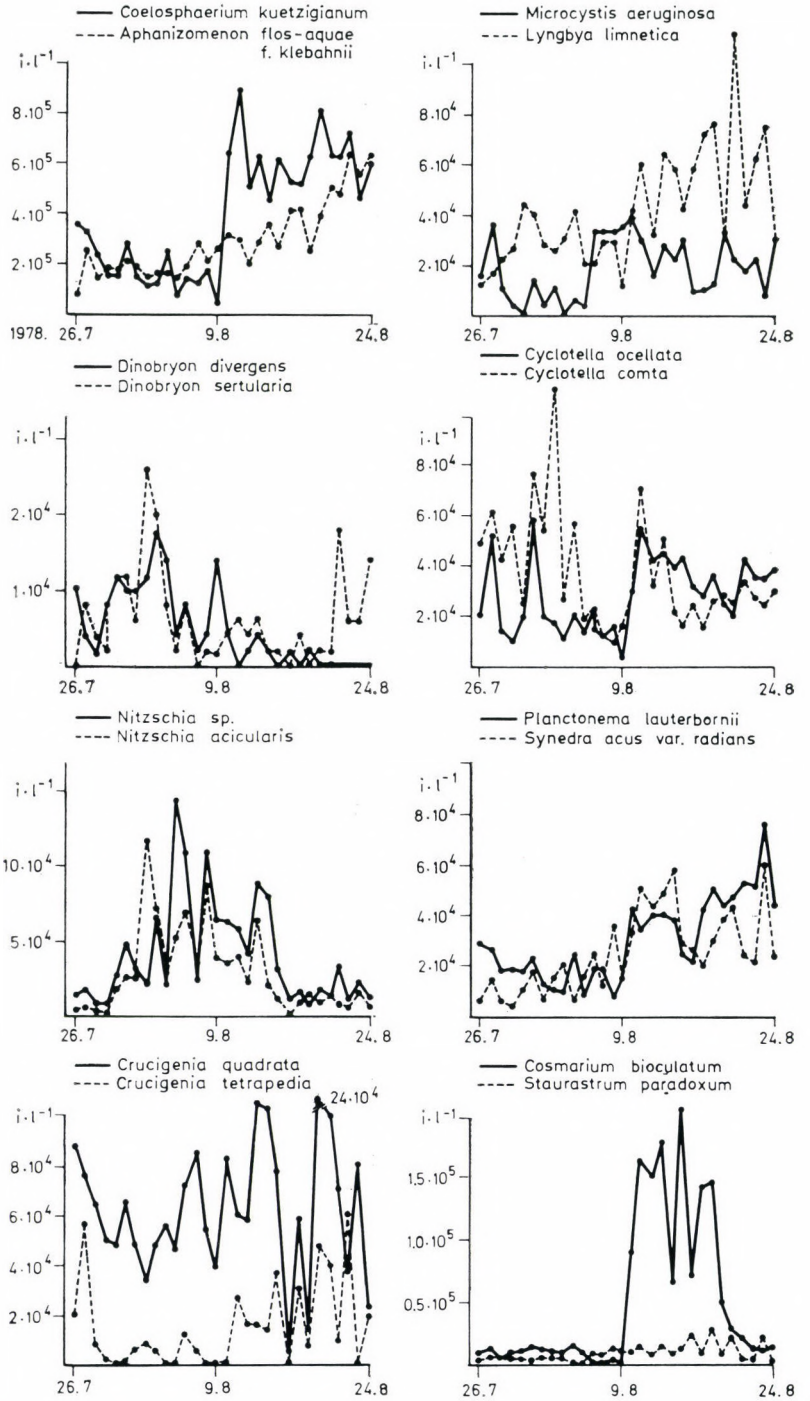

Fig. 4. Population dynamics of some species between 26 July and 24 August, 1978, which are numerically important in the phytoplankton community

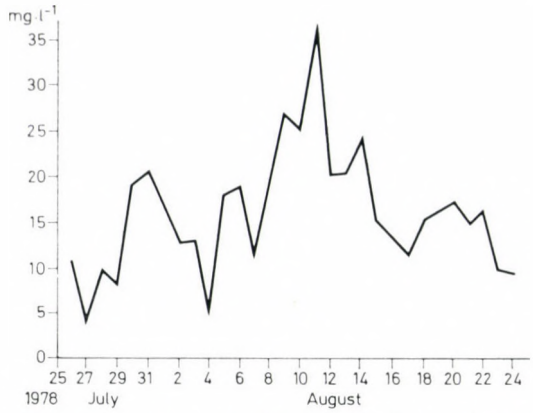

Fig. 5. Seston content of the water between 26 July and 24 August, 1978

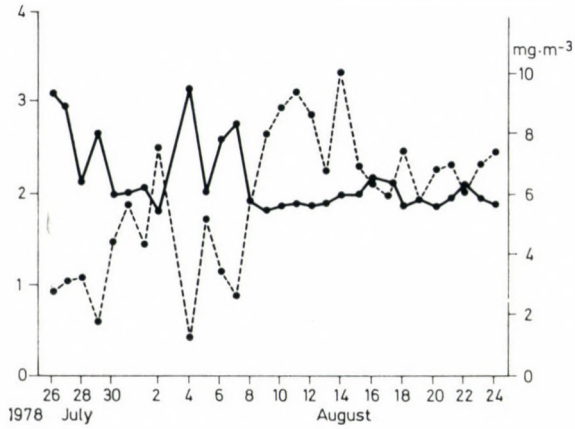

Fig. 6. Chlorophyll-a content (mg · m^{-3}: - - - - -) and PER (———) between 26 July and 24 August, 1978

of cyanophytes rose markedly becoming primary constituents of total numbers. Changes in total biomass were mainly influenced by the phylum *Pyrrophyta*, to which the large alga *Ceratium hirundinella* belong.

Monthly averaged abundance of determined 169 species is given in Table 2, according to the scale as follows.

Change in numbers of some important species of the phytoplankton are illustrated in Figs 2—4.

Seston content of the water was greatly influenced by the stirring-up effect of the storms (Fig. 5). High values found at the middle of the 1978 period are due to a storm.

Chlorophyll-a content was low and variable over the first 15 days, high and constant thereafter (Fig. 6). PER was high and variable in the beginning, its values declined later. It is noteworthy that the increase in chlorophyll-a

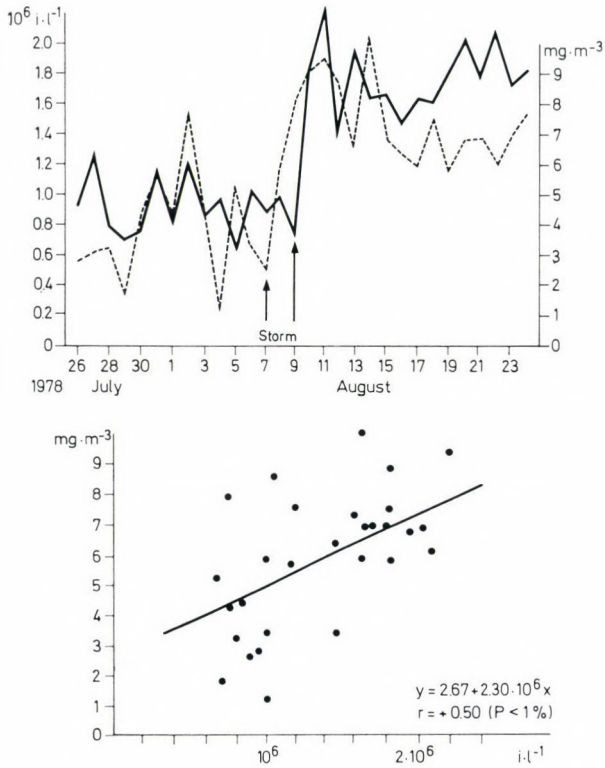

Fig. 7. Chlorophyll-a content of water (mg · m^{-3}: – – – – –) and biomass of phytoplankton (mg · l^{-1}: ———) and the stochastic relationship between the two variables

content occurred before that of the number or biomass (Fig. 7; Table 1). There was closer stochastic correlation between seston content and chlorophyll-a content ($r = +0.68$, $p = 0.1\%$, $n = 29$) than between chlorophyll-a content and the number of algae ($r = +0.5$, $p = 1\%$, $n = 29$).

Discussion

1. There is a marked increase in the number of eutrophication indicator species over three years, which is mainly due to increase in numbers of cyanophytes and chlorophytes. The growth of number of individuals and dominance of cyanophytes and chlorophytes may be considered to be the most critical feature of the lake;

	1976		1977		1978	
	ind · l^{-1}	%	ind · l^{-1}	%	ind · l^{-1}	%
total	1,259,277	100	861,252	100	1,353,261	100
chlorophytes	149,877	12	226,454	26	284,949	21
cyanophytes	201,937	16	306,192	36	804,128	59
chrysophytes	772,526	61	304,436	35	227,983	17

Table 2

Determined alga species, their volume and numbers found in the three study periods

	Volume (μm^3)	1976	1977	1978
CYANOPHYTA				
Chroococcales				
1. *Aphanocapsa delicatissima**	150	4	—	1
2. *A. elachista*	150	—	2	2
3. *Chroococcus limneticus*	1,800	3	3	3
4. *C. minutus* var. *obliteratus*	1,700	4	3	3
5. *Coelosphaerium kuetzigianum**	2,000	3	4	5
6. *C. naegelianum**	2,000	1	—	2
7. *Gomphosphaeria aponina*	2,000	—	1	1
8. *G. lacustris*	2,000	—	3	4
9. *Merismopedia elegans*	3,600	—	—	1
10. *M. glauca*	660	1	2	2
11. *M. minima*	50	—	—	1
12. *Microcystis aeruginosa**	975	4	3	4
Hormogonales				
13. *Anabaena aphanizomenoides**	400	2	—	—
14. *A. schermetievi**	5,000	—	1	—
15. *A. spiroides**	300	—	1	1
16. *Aphanizomenon flos-aquae* f. *klebahnii**	360	4	5	5
17. *A. issatschenkoi**	400	2	3	3
18. *Lyngbya circumcreta*	175	3	3	3
19. *L. limnetica**	95	5	4	4
20. *Nostoc* sp.	480	—	1	—
21. *Oscillatoria* sp.*	700	—	—	1
22. *O. granulata**	800	—	—	1
23. *O. minima**	314	—	—	1
24. *O. ornata**	1,800	—	1	—
25. *O. tenuis**	180	—	1	—
26. *Spirulina subtilissima*	1,000	—	1	1
EUGLENOPHYTA				
Euglenales				
27. *Euglena* sp.	2,000	4	2	2
28. *E. acus*	3,900	3	3	2
29. *E. caudata*	3,700	3	3	3
30. *E. tripteris**	8,130	2	2	2
31. *Lepocynclis* sp.	2,400	1	1	—
32. *Phacus* sp.	1,500	—	2	—
33. *Ph. acuminatus*	2,500	—	—	2
34. *Ph. pyrum**	1,770	2	3	2
PYRROPHYTA				
Cryptophyceae				
35. *Cryptomonas* sp.	1,700	1	—	—
36. *C. caudata*	1,500	4	3	3
37. *C. erosa**	1,700	3	3	—
38. *C. ovata**	3,000	1	1	—
Dinophyceae				
39. *Ceratium hirundinella*	53,000	3	3	3
40. *Peridinuum* sp.	10,000	—	2	—
41. *P. inconspicuum**	4,600	4	2	2

Table 2 (continued)

	Volume (μm^3)	1976	1977	1978
CHRYSOPHYTA				
Xanthophyceae				
42. *Planctonema lauterbornii**	1,360	2	4	4
Chrysophyceae				
43. *Dinobryon divergens**	1,400	4	2	3
44. *D. sertularia*	1,400	4	3	3
45. *D. sociale*	1,400	—	1	—
Bacillariophyceae				
46. *Amphora ovalis*	5,300	3	2	2
47. *A. ovalis* var. *pediculus*	1,500	1	1	—
48. *Attheya zachariasii*	8,760	2	3	3
49. *Campylodiscus noricus*	10,000	1	1	1
50. *Cocconeis placentula*	800	—	2	2
51. *Cyclotella comta*	3,100	3	4	4
52. *C. ocellata*	565	4	2	4
53. *Cymatopleura elliptica*	138,000	1	1	1
54. *C. solea*	25,500	1	1	1
55. *Cymbella ventricosa*	4,600	1	1	—
56. *Diatoma vulgare*	2,000	1	1	1
57. *Diploneis puella*	400	2	2	2
58. *Epithemia* sp.	800	1	—	—
59. *E. sorex*	800	1	1	—
60. *Fragilaria construens**	13,340	2	2	2
61. *Gomphonaema* sp.	500	2	—	—
62. *G. acuminatum*	500	—	—	1
63. *G. bohemicum*	500	—	—	1
64. *G. ventricosum*	5,300	—	2	1
65. *Gyrosigma distortum*	10,600	1	1	1
66. *G. kuetzingii*	10,600	1	1	1
67. *G. prolongatum*	28,250	2	1	1
68. *Melosira granulata**	49,480	2	2	2
69. *Navicula anglica*	350	—	2	1
70. *N. cryptocephala*	350	4	2	2
71. *N. gracilis*	350	1	—	—
72. *N. hungarica* var. *capitata*	350	1	2	1
73. *N. radiosa*	350	—	2	2
74. *Nitzschia* sp. 1.	400	5	4	4
75. *Nitzschia* sp. 2.	3,000	—	3	3
76. *N. acicularis**	200	5	4	4
77. *N. closterium*	200	3	2	1
78. *N. commutata*	4,000	—	1	1
79. *N. tryblionella* var. *victoriae*	600	1	—	1
80. *Rhisosolenia eriensis*	4,600	2	3	2
81. *Rhoicosphaenia curvata*	5,300	1	1	1
82. *Stenopterobia pelagica*	1,000	—	1	1
83. *Surirella biseriata*	20,000	—	1	—
84. *S. robusta* var. *splendida*	125,000	2	2	1
85. *Synedra acus* var. *radians*	600	4	4	4
86. *Tabellaria* sp.	2,300	1	2	1
87. Other *Bacillariophyta*	600	—	2	—

Table 2 (continued)

	Volume (μm^3)	1976	1977	1978
CHLOROPHYTA				
Volvocales				
88. *Chlamydomonas* sp.*	300	—	3	—
89. *Ch. reinhardii**	300	—	—	3
90. *Gonium pectorale*	32,000	—	1	1
Tetrasporales				
91. *Elakatothrix acuta*	550	—	2	1
92. *E. lacustris*	550	3	3	3
Chlorococcales				
93. *Actinastrum hantzschii**	140	1	1	1
94. *Ankistrodesmus acicularis**	300	—	3	2
95. *A. acicularis* var. *mirabilis**	300	—	2	1
96. *A. angustus**	30	3	3	3
97. *A. arcuatus*	250	—	2	1
98. *A. braunii* var. *pusilla*	250	—	1	—
99. *A. convolutus*	250	—	1	—
100. *Ankyra judayii*	200	—	1	—
101. *Botryococcus braunii*	3,600	—	3	3
102. *Chodatella balatonica*	300	4	2	2
103. *Closteriococcus viernheimiensis*	250	—	2	3
104. *Coelastrum microporum**	2,150	—	3	3
105. *C. reticulatum*	1,500	2	2	3
106. *C. sphaericum*	1,000	—	—	1
107. *Crucigenia quadrata*	65	1	4	4
108. *C. tetrapedia**	65	4	2	3
109. *Dictyosphaerium ehrenbergianum*	1,600	—	2	2
110. *D. pulchellum**	1,600	1	3	3
111. *D. pulchellum* var. *ovatum*	1,600	—	—	2
112. *Dicellula* sp.	550	—	1	—
113. *D. planctonica*	550	—	1	—
114. *Echinocoeleum elegans*	535	—	—	2
115. *Franceia echidna*	250	—	1	—
116. *F. javanica*	260	—	—	1
117. *F. polychaeta*	1,400	—	1	—
118. *Gloeoactinium limneticum*	240	—	2	1
119. *Hyaloraphidium contortum*	300	—	1	—
120. *Kirchneriella contorta*	300	—	2	2
121. *K. cornuta*	300	—	1	—
122. *K. obesa*	500	—	3	2
123. *Lagerheimia genevensis**	300	—	1	—
124. *Micractinium pusillum*	800	1	—	1
125. *Nephrochlamys subsolitaria*	300	—	1	1
126. *Oocystys* sp.	400	5	3	4
127. *O. solitaria*	113	4	2	1
128. *Oocystidium ovale*	810	—	—	2
129. *Pediastrum boryanum**	3,000	2	2	1
130. *P. boryanum* var. *flexuosum*	1,000	—	—	1
131. *P. duplex**	10,000	2	1	1
132. *P. simplex*	5,000	2	2	2
133. *P. simplex* var. *duodenarium*	5,000	—	1	1
134. *P. simplex* var. *echinulatum*	5,000	—	1	—
135. *P. simplex* var. *radians*	1,000	—	1	1
136. *P. tetras*	1,000	—	—	1

Table 2

	Volume (μm^3)	1976	1977	1978
137. *Quadricoccus ellipticus*	240	—	2	1
138. *Scenedesmus acuminatus**	150	1	1	2
139. *S. acutus*	500	—	2	3
140. *S. arcuatus**	400	2	1	2
141. *S. balatonicus*	4,000	2	1	2
142. *S. ecornis* var. *disciformis**	2,000	2	2	2
143. *S. intermedius*	100	2	2	3
144. *S. quadricauda**	395	4	3	3
145. *Schroederia nitzschioides*	2,000	—	2	2
146. *Sch. robusta*	500	3	3	3
147. *Sch. setigera**	400	—	—	2
148. *Sch. setigera* f. *minor*	300	—	—	2
149. *Selenastrum bibraianum*	500	—	2	2
150. *Tetrachlorella alternans*	1,400	—	2	3
151. *Tetrahedron caudatum**	250	4	2	2
152. *T. incus*	1,000	—	2	2
153. *T. minimum**	250	—	2	2
154. *T. triangulare*	250	—	—	1
155. *Tetrastrum glabrum*	500	2	3	3
156. *T. hastiferum*	500	1	2	1
157. *T. staurogeniaeforme*	500	2	3	2
158. *Westella botryoides*	1,050	—	1	—
Desmideaceae				
159. *Closterium* sp. 1.	20,000	—	1	1
160. *Closterium* sp. 2.	3,800	—	2	2
141. *C. aciculare**	3,800	1	3	3
162. *C. acutum*	3,800	1	1	—
163. *C. acutum* var. *variabile*	700	2	3	3
164. *C. parvulum**	13,100	—	1	1
165. *Cosmarium bioculatum*	535	—	—	4
166. *C. menenghinii*	200	—	2	—
167. *Staurastrum paradoxum*	2,400	4	3	3
168. *S. paradoxum* var. *aequabile*	2,400	—	2	2
169. Other *Chlorophyta* sp. (filamentous)	500	—	—	2

Explanation: —: does no exist
1: average number over the month is below 300 ind $\cdot$ l^{-1}
2: between 300 and 3,000 ind $\cdot$ l^{-1}
3: between 3,000 and 20,000 ind $\cdot$ l^{-1}
4: between 20,000 and 80,000 ind $\cdot$ l^{-1}
5: above 80,000 ind $\cdot$ l^{-1}
*: eutrophication indicator species

These properties are good indication of the growing eutrophication too. Although the above-mentioned trends may be due to seasonal phenomena, knowing the previous state of Lake Balaton, I consider them to be a good sign of eutrophication.

2. Several interesting population dynamics were described, which imply phasic changes in seasonal succession of the phytoplankton community.

Diversity and cluster analysis are needed to reveal exact phasic cyclicity of the data.

3. The closer correlation of chlorophyll-a with seston content than with alga number reflect weather dependent stirring-up of the bottom-living algae, and, similarly, a release of the pheophytin content of decomposing algae. Preliminary studies showed that in fine weather, net chlorophyll-a content per m^2 may be one order higher at the sediment water level than in the water above it. If pheophytin and chlorophyll-a contents are pooled, this difference may increase to a magnitude of two or three (!) orders.

4. During the changes due to heavy storms between 7 and 11 August 1978, increase in chlorophyll-a content occurred two days before that of algae numbers. At the same time there was a decrease in inactive pigments in favour of photosynthetically active chlorophyll-a (i.e. PER decreased). Simultaneous studies on the increase in seston content and production (the latter: G.-Tóth 1980) suggests release of plant nutrients from the sediment. Production before 10 August, 1978 was about half as much as after that date. This observation is in accordance with other short-term studies on the seston and phosphorous content of Lake Balaton (Oláh et al. 1977).

Summary

Changes in numbers and biomass of phytoplankton of Lake Balaton at Tihany were studied by means of daily sampling for one month in the summers of 1976, 1977 and 1978, respectively. Seston- and chlorophyll-a content of the water were also measured in 1978, and PER was also calculated. 169 species and subspecific taxons were found over the three years (*Cyanophyta*: 26, *Euglenophyta*: 8, *Pyrrophyta*: 7, *Chrysophyta*: 46, *Chlorophyta*: 82). Eutrophic indicator species increased in number. The increase in numbers and biomass over the three years is primarily due to increase in abundance of cyanophytes and chlorophytes. These data reflect the advanced state of eutrophication of the lake. Population dynamics of some species imply phasic nature of the seasonal succession of the alga-community.

Chlorophyll-a content and the PER showed a correlation with the occurrence of storms. These effects are partly due to the appearance of bottom-living algae, partly due to the release of plant nutrients from the sediment.

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NICHE STUDIES ON SOME PLANT SPECIES OF A GRASSLAND COMMUNITY, VI[1]

THE PROBLEM OF ECOLOGICAL SPECIALISM AND GENERALISM: NEW APPROACHES

By

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Ecological specialization has not been studied at depth so far. As was expounded by the authors in their previous studies, the degree of specialization can be expressed by the breadth value of the niche based on ecological measurements. To complete this a suggestion for the expression of the information content will be put forward. A high value of the information content is a sign of ecological specialization; ecological generalists usually have in low information values. Starting from the fact that the interspecific association should reflect the ecological effects, the ISC matrix was studied by the centroid method, and the specialist and/or generalist character of the species was estimated on the basis of communalities and of the $1\text{-}h^2$ values. The species order can vary on the communality (or $1\text{-}h^2$) axis (and on the basis of the 2I values) according to the species composition.

On the basis of the answers given to the ecological factors within one association the species are qualified as generalists or specialists (or of a transitional character between these two extreme categories). The generalist species fill a large part of the niche space, their niche breadth is almost always wide in most of the factors; their average overlap value (their average in relation to the other species) as well as their species and community effect values (VANDERMEER 1972) are high. The specialist species occupy only a small part of the niche space, mostly such parts that are hardly or not at all used by the generalists. The niche breadth of these species is narrow, their average overlap is low, and their species or community effect can hardly be detected.

The above interpretation is inferred from the partition of concrete ecological factors ("sources"). However, the differentiation in generalists and in specialists can also be made another approach, by means of the cenological affinity (association), considering that in this formation also the answers to the ecological factors are involved. The centroid approach proves a useful method in this context.

The following possibility offers itself in relation to the centroid method: Starting from the ISC (interspecific correlation) matrix, we can estimate the communality and specificity of the species. Since communality represents the part of the variance of the variable (here the species) which is attributable to the common factor k (LAWLEY and MAXWELL, 1963; DAGNELIE 1960), the communality values of the generalist species will be high. The part of variance which is not attributable to the common factor k is considered the specificity of the species; this is high in specialist species. However, on the basis of the analysis it cannot be established which is the real ecological factor, for which a given species will be specialist. This will have

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to be further analysed in detail with respect to concrete ecological factors if we wish to detail specificity in this context.

Our method provides a possibility to state an estimate by the touchstone of the cenological results to what extent are the ecological factors studied relevant in bringing about the cenological picture. The method can be enlarged: the order of the species overlap (average overlap) can be compared with the order of the cenological communality; it can be decided by means of the alternative calculations which is the factor (factor combination; scale, etc.) where the order corresponds the most with that of the communalities and it may influence the interspecific relationships as well.

Another method of differentiation between generalists and specialists is by information content. Some ecological factors or factor combinations can be predicted on the basis of the frequency of certain species. It can be presumed that the specialist species provides more information on certain ecological factors (factor combinations) than does the generalist.

The two approaches outlined above start from different bases. In the ISC matrix, the result of long development and of adaptation to a great number of partly unknown ecological (and cenological) factors manifests itself; in the given case, the estimation of the information content is, however, based on a momentary situation. Nevertheless, to a certain extent this can also be traced back to the development of the association and to the adaptation of the individual populations forming the association.

In our study, the results of our investigations carried out on the basis of the above assumptions are provided.

Material and method

The data necessary for the ISC matrix were obtained from the sampling of 100 pieces of 50×50 cm squares. Presence and absence were taken as basis. The samplings took place in the grassland of Tece in Vácrátót on 29. VI, 6. VII, and 31. VIII, 1976. For the description of the vegetation see KÁRPÁTI and KÁRPÁTI (1954); FEKETE et al. (1976).

Festuca vaginata occurred in each of the squares, therefore, no correlation coefficient (r) could be calculated; *r* was replaced by the frequency of co-occurrence in a way that co-occurrence was given in the occurrence ratio of the more frequent species. From the matrix compiled in this way, three centroids were extracted (CATTELL 1952; LAWLEY and MAXWELL 1963); knowing the loadings of the centroids, the communality (and specificity) values of the species were calculated.

The information content was used on the basis of the combinations described previously (FEKETE et al. 1976; PRÉCSÉNYI et al. 1977), after the method of KULLBACK (1959) and ORLÓCI (1975). We chose the combinations because these showed the real situation rather more accurately than the various factors separately.

Results and discussion

1. Centroid analysis and information content

The communality of *Thymus* and *Festuca* is very high and there is hardly any difference between the centroid loadings of the two species. After these two species there follow *Medicago*, *Centaurea* and *Carex*, then *Euphorbia* and *Cynodon*, and *Equisetum*. It is *Fumana* that has the lowest communality and the highest specificity (Tables 1 and 2). *Festuca* and *Thymus* are very near to

Table 1

The ISC matrix of species

Species	*Thymus*	*Medicago*	*Carex*	*Cynodon*	*Euphorbia*	*Fumana*	*Equisetum*	*Centaurea*
Festuca	0.85	0.75	0.67	0.49	0.46	0.29	0.20	0.16
Thymus		0.74	0.71	0.45	0.46	0.27	0.22	0.18
Medicago			0.67	0.47	0.47	0.27	0.20	0.11
Carex				0.46	0.58	0.22	0.28	0.24
Cynodon					0.43	0.24	0.24	0.24
Euphorbia						0.22	0.33	0.30
Fumana							0.10	0.00
Equisetum								0.45

Table 2

The centroid loadings, communalities (h^2), and specificity values ($1 - h^2$) of species

Species	I	II	III	h^2	$1-h^2$
	Loadings				
Festuca	0.84	0.37	0.09	0.85	0.15
Thymus	0.84	0.38	0.14	0.87	0.13
Medicago	0.78	0.30	−0.07	0.70	0.30
Carex	0.79	0.08	−0.08	0.64	0.36
Cynodon	0.61	−0.05	0.17	0.40	0.60
Euphorbia	0.66	−0.14	0.19	0.49	0.51
Fumana	0.30	0.07	−0.13	0.11	0.89
Equisetum	0.40	−0.36	−0.08	0.30	0.70
Centaurea	0.40	−0.62	−0.33	0.65	0.35

each other in each case (on each axis). *Cynodon* and *Euphorbia* also lie quite close to each other. While in most species the greatest loadings occurred in the first factor axis, those of *Centaurea* occurred in the second factor. *Fumana* and *Equisetum* have no great loadings in any of the factors. We can see that in the combinations *Fumana* is of the highest information content both in summer and autumn. The order of the species is not the same in the combinations during the summer and the autumn, although certain species are almost on the same places in the order. It is *Equisetum* that shows the greatest deviation (Table 3).

Hardly any or no relationship can be detected between the niche characteristics, communality or specificity and the information content. This can

Table 3

The mutual information content of species (2 I)

Species	Summer	Autumn
Festuca	23.0120	23.8244
Thymus	8.1354	15.9474
Medicago	23.2582	18.7178
Carex	17.2714	15.2520
Cynodon	12.4550	18.6528
Euphorbia	23.8382	17.7152
Fumana	34.7746	25.2104
Equisetum	9.1546	24.1642
Centaurea	10.4568	13.8994

be explained by the fact that the analysis of the niche characteristics and the associations represent approaches from different bases. So much can, however, be inferred from the results that *Fumana* has the smallest overlap average, a very low species and community effect, but the greatest specificity and the greatest information content. This species, together with *Equisetum* and *Cynodon*, was indicated as specialist in our previous paper (FEKETE et al. 1976; PRÉCSÉNYI et al. 1977). Considering, however, the information content of the two latter species, it is different — on the basis of the combinations — during the summer and the autumn. It is interesting that although the communality values of *Festuca* and *Medicago* are large, their information values are also relatively high. *Thymus* has the smallest specificity values and also its information content values are low. This species could be considered as a generalist, and the *Fumana* as rather a specialist.

2. *Analysis of generalist and specialist groups*

To illustrate how the specialist or generalist character changes in dependence of species composition — if the centroid method and the information content are used for the analysis — the results of further examinations will be presented. From the 9 species, two groups were formed on the basis of whether their specificity was above 0.5 or not (this value was chosen arbitraryly). Species with lower specificity than 0.5 are called "generalist" while those with higher specificity are "specialist". *Festuca*, *Thymus*, *Medicago*, *Carex* and *Centaurea* were placed into group one, while *Fumana*, *Equisetum*, *Cynodon* and *Euphorbia* into group two. After carrying out the centroid analyses in the two groups separately we can see that in the "generalist" group the

Table 4

The centroid loadings, communalities and specificity values of "generalists"

Species	I	II	h^2	$1-h^2$	I	II	h^2	$1-h^2$
	Loadings				Loadings			
Festuca	0.90	0.13	0.82	0.18	0.90	0.24	0.86	0.14
Thymus	0.92	0.13	0.86	0.14	0.91	0.15	0.85	0.15
Medicago	0.83	−0.13	0.71	0.29	0.80	0.14	0.66	0.34
Carex	0.77	−0.13	0.62	0.38	0.80	−0.08	0.65	0.35
Centaurea					0.26	−0.41	0.23	0.77

specificity character is the highest in *Centaurea*. The generalist character of *Festuca* and *Thymus* remained. In this group, the specificity of *Centaurea* is much higher than that of the other species, and the difference between the specificities of the first and of the last member in this group (*Centaurea-Festuca*) is much greater than that in the other group. Three small groups can be separated in the "generalist" group, on the basis of the smallness of differences in the specificity values: *Festuca-Thymus*, *Medicago-Carex* and *Centaurea* (Table 4).

In the group of "specialists", *Fumana* is most of all specialist. The specificity of all the species in this group is above 0.5; the difference between the $1-h^2$ values of the species with highest and smallest specificity is small. From the four species, *Euphorbia* is the "generalist". Also within this group, three smaller groups — *Fumana*, *Equisetum-Cynodon* and *Euphorbia* — can be distinguished.

Even if *Centaurea* is placed from the "generalists" into the "specialists", *Fumana* remains the most "specialist", and *Euphorbia* the most "generalist". However, after *Fumana* follows *Centaurea*; the order is rearranged within the group (Table 5). The order is changed also among the "generalists" after

Table 5

The centroid loadings, communalities and specificity values of "specialists"

Species	I	II	h^2	$1-h^2$	I	II	h^2	$1-h^2$
	Loadings				Loadings			
Cynodon	0.58	0.22	0.39	0.61	0.61	0.09	0.38	0.62
Euphorbia	0.68	0.13	0.48	0.52	0.68	−0.01	0.46	0.54
Fumana	0.24	0.28	0.14	0.86	0.35	0.26	0.19	0.81
Equisetum	0.56	−0.36	0.45	0.55	0.48	−0.34	0.35	0.65
Centaurea	0.48	−0.37	0.37	0.63				

Centaurea has been taken out; *Carex* has become a "specialist" and *Thymus* a "generalist", although the $1-h^2$ values of the 4 species are very near to one another.

The transferring of *Centaurea* into the specialist group resulted in an increase in the specificity of *Fumana*, while it decreased that of the other species. In the "generalist" group, the $1-h^2$ value of *Carex* as "specialist" has to a certain extent increased after *Centaurea* has been taken out of the group. The $1-h^2$ value of *Centaurea* itself decreased in the "specialist" group compared to the "generalist" one.

Analysing the summer 2I values, in the "generalist" group *Festuca* dominates, in the "specialist" group it is *Equisetum* (Tables 6 and 7).

After putting *Centaurea* into the "generalist" group, we find *Medicago* at the first place, while *Centaurea* is only second last. In the specialist group without *Centaurea*, *Cynodon* stands at the first place. *Fumana* is only second in the order in both cases. The order of the autumn 2I values in the specialist group containing *Centaurea* is very similar to that of the summer values: *Fumana* stands in the first place, while *Centaurea* is again the second last. The

Table 6

The information content of "generalists"

Species	Summer	Autumn	Summer	Autumn
Festuca	16.5230	10.9580	15.1456	12.6540
Thymus	8.6242	5.6816	9.1696	7.4014
Medicago	14.3102	11.0070	15.2200	15.9736
Carex	10.2186	9.5520	10.8120	10.9356
Centaurea			9.2176	20.1764

Table 7

The information content of "specialists"

Species	Summer	Autumn	Summer	Autumn
Cynodon	12.2378	8.5736	12.7002	8.8134
Euphorbia	9.9168	7.0658	10.6570	10.0470
Fumana	14.4154	11.0308	12.3832	9.3208
Equisetum	17.1204	9.7594	10.8362	12.5720
Centaurea	10.4076	7.2414		

order changes very much in the specialist group without *Centaurea*: *Equisetum* assumes first place, while *Fumana* the is third in the order. In the "generalist" group without *Centaurea*, *Medicago* is in the first place. Transferring *Centaurea* into this group it will be first in position and *Medicago* the second. *Thymus* is the last in all cases whether we consider the summer or the autumn values, with or without *Centaurea*.

3. Comments on the differentiation of generalists and specialists

The question of specialist-generalist distinction has hardly been studied so far in plant ecological context. It is only one of the roots of the problems which has been dealt with to a certain extent, namely, the question of physiological and ecological amplitude (ELLENBERG cit. BORHIDI 1969; MCMILLAN 1959, etc.), which is virtually analogous to the fundamental — realised niche duality. The separation of ecological amplitude from the fundamental physiological potential, and the examinations related to this made it anyhow clear that the competitors in all cases mutually cut down each other's niche space, by occupying smaller or greater niche segments. It has also become clear that physiological specialization is not an inevitable condition in ecological specialization, and a physiological specialist can even become an ecological generalist if the segment of the scale of the ecological factor(s) in respect of which the species is efficient occurs in nature most frequently.

The question may arise whether a species can be found which is an obligate specialist such which behaves as a specialist in relation to every ecological factor, factor combination in case of any species composition and in all time. In the specialists examined so far, the specific physiological tolerance (for example that of heavy metals) is accompained by reduced competitive ability. It can be imagined that obligate specialists may exist in theory but the species are facultative specialists and such are also those that are called generalists. Or do the species lie between the obligate specialists and obligate generalists as two theoretical end-points, and in a certain situation one of the species lies nearer to one of the end-points, while at the same time the other species stands nearer to the other end-point ? Anyhow, there are more facts contradicting the justification of the obligate generalists than those of the obligate specialists; for example a real "ubiquist" practically does not exist, and even the species with the widest range of adaptability restrict their cenological extension at the boundaries of their occurrence; the character species of the Zurich-Montpellier phytosociological school are mostly locally valid, etc.

Anyhow considering the question of specialists and generalists, we must be aware of the fact that we are dealing with multiple-related situation and positions which have to be examined from several approaches.

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SHORT-TERM INVESTIGATIONS ON THE BACTERIOPLANKTON OF LAKE BALATON AT TIHANY

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The short-term changes of bacterioplankton were studied by daily sampling in the summers of 1976 and 1977 on Lake Balaton. The 99% of bacterioplankton was made up of floating colonies, in which the bacteria cells remained together in the course of division. 80% of colonies contained cell numbers of synchronous division and the population went through regular cycles of lag → log → stationary → death phases. The inhibited growth of colonies was presumed from these facts. The storms of previous days stirred up the nutrients from the bottom stimulating the synchronous division. This idea is supported by the results of path analysis. Moreover the succession of different morphological groups could be detected. Because of the short-term sampling turnover time could be estimated. The decreasing bacterial turnover times and the increasing organic carbon content in the water column demonstrate the accelerated eutrophication of Lake Balaton.

Introduction

Studies on the total bacterioplankton of Lake Balaton were started in the 1960-s to ascertain the amount of mass energy flow of the lake (Oláh 1969, 1970, 1971, 1972, 1973a, 1973b, 1973c; Oláh, Hajdú and Elekes 1972; Oláh and Vásárhelyi 1970a, 1970b). It became clear from these investigations that apart from seasonal studies, the characteristics of the Lake, shallowness, large open water surface, permanent stirring up effect necessitate research on the short-term changes of bacterioplankton as well. Numerous interesting phenomena have been observed studying the bacterioplankton of deep lakes, quiet impoundments and fish-ponds. One of these is the close correlation between abundance of bacterioplankton and biomass of phytoplankton (Overbeck 1968; Hajdú 1972; Kuznetsov 1970, 1974). Studies on the foodchain relationships of plankton associations reveal that in certain micro spaces the filtering pressure of zooplankton also plays a part in regulating bacterioplankton (Ponyi 1977).

The present paper is concerned with results of two short-term studies on the variation of bacterioplankton in Lake Balaton, each lasting for a period of one month. Daily records were made of the quantitative variation of bacterioplankton, water temperature, organic carbon content and turbidity of the water, wind velocity influencing the dynamic properties of the water and the phytomass of the planktonic algae. Primary aims of the investigation were to throw light on the extent and nature of the short-term variations and to reveal any relationships between the measured variables. In interpreting the results, the problem of eutrophication is briefly discussed.

Materials and methods

The investigations were carried out in the same study area as in earlier years, et Tihany, between 20 July and 18 August in 1976 and 1977. Five standard sampling stations were set out along the circumference of a circle with a radius of 40 m around the buoy, 800 m from the waterfront of the Biological Institute (Fig. 1). Sampling units were taken with a FRIEDINGER sampler from depths of 20 cm, 100 cm, 200 cm and 300 cm, in 1976 between 10

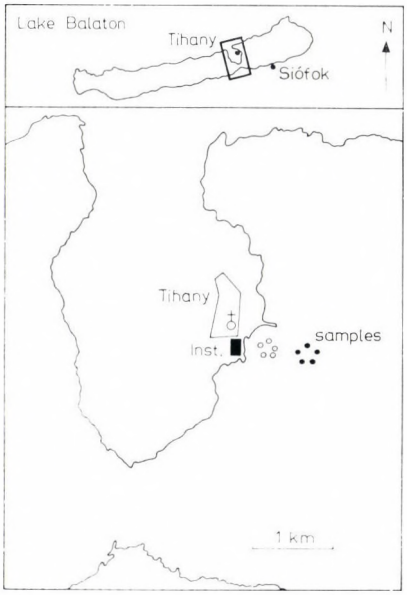

Fig. 1. Map of study area showing the sampling points

and 12 a.m., in 1977 between 10 a.m. and 3 p.m. Due to storms, on 24 and 25 July and 5, 6, 12 and 18 August, 1976 samples were taken from a similar lay-out located nearer to the shore. These points are given as empty circles in Fig. 1. At the beginning of each sampling, SECCHI-disc transparency of the water was measured at the buoy and water temperature reading were taken from three depths. The organic carbon content of the water was determined by OSTAPENYA's method (1976). In 1977 the chemical oxygen demand of the water was determined by chromate method (FELFÖLDY 1972) and the organic carbon content was calculated from this by OSTAPENYA's coumping principles. Details of phytoplankton studies are not presented here, merely phytomass values are given. These were calculated from the numbers and volume of algae, the latter based puon volumes of geometric bodies equivalent to the algal cells. Microalgae were studied by the membrane filter method (RAZUMOW 1932; G.-TÓTH and PADISÁK 1978), whereas algae larger than 10 μm were viewed through reversed plankton microscope (UTERMÖHL 1958). Wind velocity values taken at the Meteorological Station of Siófok were supplied by the Archives of the National Meteorological Institute. Quantitative counts of bacterioplankton were made from a mixture of the samples of a day by the membrane-filtering method. Microscopical analysis was carried out according to morphological groups: individual cocci, diplococci, bacilli and spirilli and floating bacterial colonies containing coccus-coccoid cells were counted. Colonies were counted according to the following size categories: cca 5 μm, cca 15 μm, greater than 15 μm. Counting the number of cells in a large number of colonies, the average number of cells was established for each of the size categories. Bacterial biomass was computed according to RODINA (1972). Complementary tests were carried out to assess the degree of shrinking effect the membrane filtering method might have on the bacterial

cells. Coccus strains from the lake were isolated on nutrient agar and the preparation made up thereafter, checking the size of cocci at every step. It was found that the this method resulted in a certain degree of schrinkage in the cells, and a multiplying factor (M = 1.32) was established to correct this effect. Bacterial biomass was expressed in mg · litre^{-1}.

Results

No substantial thermal stratification was found in the lake. Increase in wind velocity resulted in total stirring up of the water body. This is apparent from the sharp decrease in SECCHI-disc transparency and sudden increase in particular organic carbon content (Figs 2 and 3). At the same time there was always a decrease in water temperature.

Intensive short-term changes were also experienced with an abundance of bacterioplankton.

The quantity of bacterioplankton somewhat decreased from 1976 to 1977, but the bacterial counts never dropped below the 10^5 ind · ml^{-1} level. On the other hand, values in

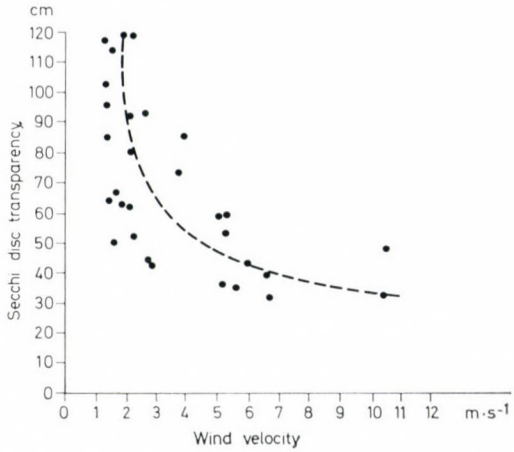

Fig. 2. Relationship between wind velocity and Secchi-disc transparency between 20 July and 18 August, 1977 at Tihany

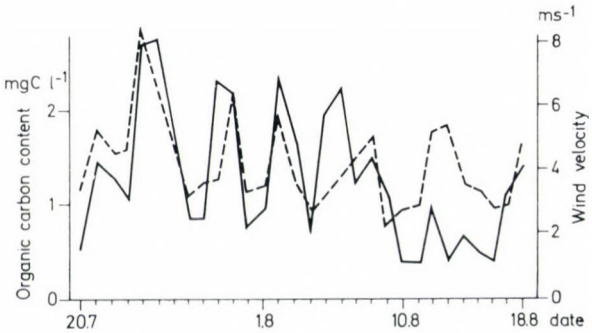

Fig. 3. Daily changes in average wind velocity (———) and particular organic carbon content of the water (– – – –) at Tihany, between 20 July and 18 August, 1976

the mesotrophic order of 10^6 ind · ml^{-1} also occurred. This is significant in that previous findings indicated that the quantity of bacterioplankton was at a minimum in the summer months, when oligotrophic seasonal dynamics were typical (OLÁH 1973a).

The majority of bacterioplankton (more than 99%) consist of the coccus-coccoid group. Also, most of these occurred in colonies (Table 1). As a result of this dominance, short-term changes in total bacterioplankton in fact reflect the dynamics of colonial coccus-coccoid populations. The relative frequency distribution of three categories of colonies in the daily samples led to an interesting finding. The first day after a storm mainly colonies of the 5 μm

Table 1

Mean of counts and biomass of various morphological groups of bacterioplankton at Tihany between 20 July and 18 August, 1976 and 1977

Morphological group	1976		1977	
	Mean of counts i · ml^{-1}	Mean of biomass mg · l^{-1}	Mean of counts i · ml^{-1}	Mean of biomass mg · e^{-1}
Coccus-coccoid	$29.7639 \cdot 10^4$	0.06020	$22.8186 \cdot 10^4$	0.04705
Diplococcus	$9.21 \cdot 10^2$	0.000018	$2.81 \cdot 10^2$	0.000010
Bacillus	$0.935 \cdot 10^3$	0.00092	$0.636 \cdot 10^3$	0.00044
Spirillum	$1.53 \cdot 10^1$	0.00023	$1.17 \cdot 10^1$	0.00017
Total bacteria	$29.8992 \cdot 10^4$	0.061368	$22.9001 \cdot 10^4$	0.04767

Table 2

Contingency table to study the synchronous cell division of colonial bacteria

Categories of classification	2^4	2^5	2^6	2^7	2^9	2^{10}	Unclassifiable
Number of cells per colony	15	30	63	122	650	900	3500
	14	34		131	450	1100	1400
	12	32		120	600	1000	1500
	20	37		110	650		1500
	20	32		118	450		1600
	15	32		110	500		47
	16	34			600		52
	12	27			680		82
	19				470		82
	14						25
	20						
Theoretical frequency (e)	16.00	32.00	64.00	128.00	512.00	1024.00	
Observed frequency (a)	16.09	32.25	63.00	118.50	561.11	1000.00	
$\chi^2 = \frac{(a-e)^2}{e}$	5.9963						
Degrees of freedom (n)	5						
	$50\% > P > 30\%$						

two-three days later colonies of the 15 μm category dominanted, and this phenomenon was observed in both study periods. Thus, by frequent sampling it was possible to follow the expansion of the colonies of coccus-coccoid population.

The number of cells was also counted in a large number of colonies and it became apparent that in most cases the actual number of synchronous cell divisions was characteristic for the colonies. A contingency table illustrates the above (Table 2). 47 colonies were randomly chosen for the χ^2-test and 38 of these could be allocated to numbers of some powers of 2. This means that 80% of the colonies contained cell numbers with synchronous division. The

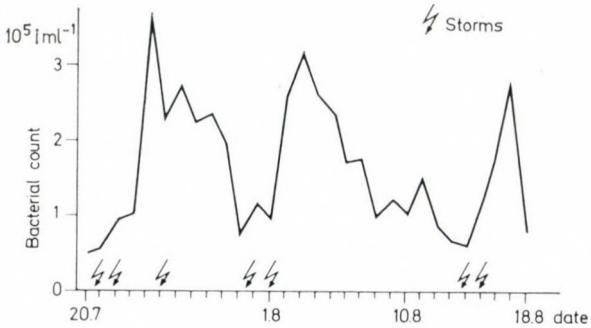

Fig. 4. Bacterial counts of floating coccus-coccoid colonies at Tihany between 20 July and 18 August, 1977

population dynamics of colonial bacteria showed that the population went through regular cycles of lag → log → stationary → death phases (Fig. 4). Since by all signs the colonies went through uninhibited divisions, the frequent sampling made estimation time possible. For this, two regular log phases were selected from the 1977 data-series and generation time was estimated as 30.4 and 34.0 hours, respectively. Further analysis of the data from 1977 also indicated that reproductive activity of the coccus-coccoid group was stimulated by the storms stirring up sediments in the lake. Close negative correlation was found between coccus-coccoid counts and wind velocity the day of sampling, but a close positive correlation between the counts and wind velocity of the day, the latter having the stirring-up effect (Table 3/b). These two correlation coefficients indicate that the number of coccus-coccoid bacteria does not directly depend on a state of churned-up water e.g. as a result of releasing large numbers of bacteria from the sediment, but in some indirect way. It may be connected with the release of some nutrients into the water. Negative correlation was found between coccus-coccoid counts and water temperatures in both study periods (Tables 3/a and 3/b). This is quite understandable, since water temperatures always dropped during storms and warming up took place slowly, only after some days by which time bacterial became abundant. Algal phytomass correlated with coccus-coccoid counts in both study periods.

Correlation coefficients do not throw light on the nature of the relationship between abundance of colonial bacteria and the various environmental variables whether stochastic or causal effects. An appropriate method is path analysis (Sváb 1973; Précsényi and Bárdos 1974). Three "independent" variables were studied: wind velocity of the previous day as stirring-up effect (X_1), water temperature (X_2) and algal phytomass (X_3). Initially, Secchi-disc transparency was considered for X_1 but then it was turned down in preference for the present choice, since the relationship between Secchi disc transparency and wind velocity is curvilinear (Fig. 2). Sediments could still have been lifted up after it was no longer possible to

Table 3/a

Results of correlation analysis between counts of various morphological groups of bacteria and some parameters in 1976 at Tihany

Bacterial count	Water temperature	Secchi-disc transparency	Particulate organic carbon content	Algal phytomass
Total count	−0.014	−0.340	−0.370	0.238
Coccus-coccoid	−0.194	−0.214	−0.365	0.243
Bacillus	0.266	0.385	−0.256	−0.010
Diplococcus	0.013	−0.085	−0.131	0.080
Spirillum	0.016	0.454	−0.136	−0.096

Table 3/b

Results of correlation analysis between counts of various morphological groups of bacteria and some parameters in 1977 at Tihany

Bacterial count	Water temperature	Secchi disc transparency	Particulate organic carbon content	Algal phytomass
Total count	−0.577	−0.076	0.074	0.451
Coccus-coccoid	−0.519	−0.074	−0.072	0.483
Bacillus	0.263	−0.276	0.531	0.061
Diplococcus	−0.020	−0.213	−0.104	0.066
Spirillum	0.130	−0.004	0.003	0.171

Suppl.: $r_{\text{coccus-wind velocity}} = -0.891$
$r_{\text{coccus-wind velocity of previous day}} = 0.783$

detect changes in transparency. The dependent variable was the coccus-coccoid count (Y). Since this group constituted over 99% of total bacterial counts, the results of path analysis (Table 4 and Fig. 5) would probably hold true for the latter as well.

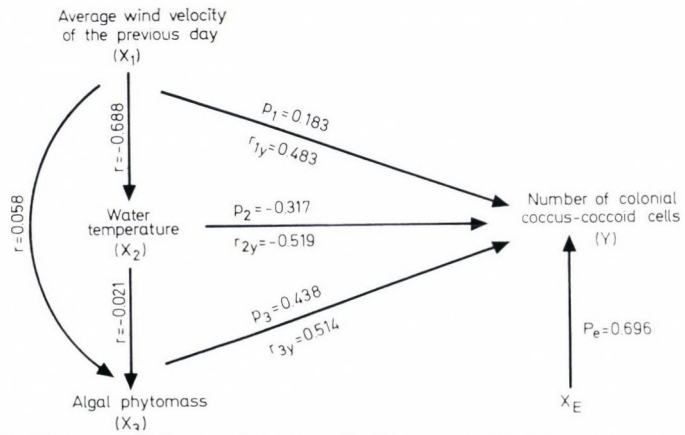

Fig. 5. A path diagram of the environmental effects on colonial coccus-coccoid abundance

Table 4

Results of a path analysis on the effects of environmental variables on bacterial counts

Independent variable	Nature of effect		Degree of effect
Wind velocity of the previous day (X_1)	Direct	p_1	0.183
	Indirect	x_2	0.218
	Indirect	x_3	0.025
Water temperature (X_2)	Direct	p_2	−0.317
	Indirect	x_1	−0.126
	Indirect	x_3	−0.009
Algal phytomass (X_3)	Direct	p_3	0.438
	Indirect	x_1	0.010
	Indirect	x_2	0.092

With partitioning r_{1y}; r_{2y}; r_{3y} correlation coefficients into direct p_1; p_2; p_3 and indirect x_1; x_2; x_3 effects (Table 4), the following can be seen:

A relatively close correlation was observed between coccus-coccoid counts and wind velocity of the previous days (stirring-up effect) ($r_{1y} = 0.483$). The relationship, however, is only partly attributable to the direct effect of stirring-up ($p_1 = 0.183$), indirectly temperature was also effective ($x_2 = 0.218$).

In the relatively close negative correlation between bacterial count and water temperature ($r_{2y} = -0.519$), the indirect effect of the stirring-up of the previous day is present ($x_1 = -0.126$) and the direct effect of temperature is in fact less ($p_2 = -0.317$).

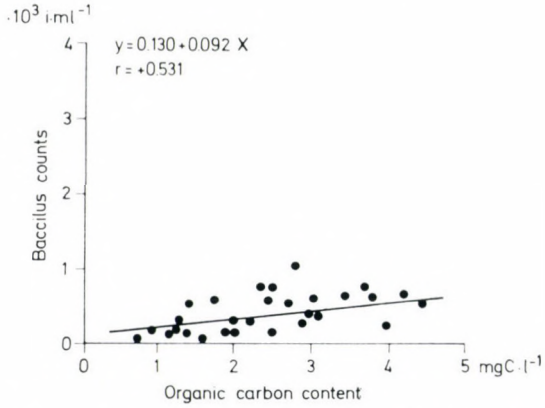

Fig. 6. The effect of organic carbon content of the water on bacillus counts in 1977 at Tihany

The positive correlation between bacterial counts and algal phytomass ($r_{3y} = 0.514$) is in fact chiefly attributable to the direct effect of phytomass ($p_3 = 0.483$).

The most striking result of the analysis was that the global effect of the variables not studied could also be determined. This dependence turned out to be 52.7% (dependence on undetermined effects $= 1 - R^2 \cdot 100\%$, where $R^2 = 0.473$ is the multiple determinational coefficient). On the path diagram (Fig. 5) X_E stands for the undetermined effects and the extent of these effects is expressed by the p_ϵ path coefficient. It is probable that these factors

are nutrient components that are released into the body of water but the churning-up only roughly represents these effects.

Diplococcus counts appeared to be the most independent of the measured variables. Spirilli showed some relationship with SECCHI disc transparency in 1976 ($r = 0.454$) but in 1977 the relationship was not observed. It is worthwhile mentionning the changes in bacillus counts over the second study period. Close correlation was observed between total organic carbon content of the water and bacillus counts (Table 3/b and Fig. 6).

Discussion

Of the physico-chemical factors in 1977 the correlation between total organic carbon content and SECCHI-disc transparency was not as high as in 1976, when particulate organic carbon content was measured (r_{part}C-Secchi = = —0.440; r_{total}C-Secchi = —0.284). This could be attributed to the method employed: in 1977 the organic carbon fractions dissolved in water were also determined, therefore the stirred-up detritus did not significantly contribute to the values.

The eutrophication process is apparent when organic carbon content data of three consecutive years are compared (Fig. 7). Since preliminary studies were carried out in 1975, it was possible to compile data for three years. It must be admitted part of the 1977 maximum is due to the dissolved organic carbon content, but no doubt it is mainly due to the accumulation of detritus.

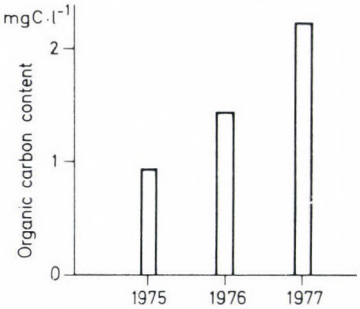

Fig. 7. Increase in the organic carbon content of open water indicates eutrophication. Mean values for the months of July and August at Tihany. 1975 and 1976: particulate organic carbon, 1977: total organic carbon (particulate + dissolved)

Total bacterial counts were in the mesotrophic intervals (scale as in RODINA 1951; DAUKSTA 1967) in the study periods, but occasionally outstanding values were also obtained. A similar state was observed in the 1960-s in the bay of Keszthely which is presently the most eutrophic part of the lake. There outstanding values were recorded ever more frequently in the beginning of the 1970s and finally stabilised with high bacterial counts (OLÁH 1973a). Initially this was attributed to low water-level, but today it is well known that this phenomenon accompanies eutrophication (GORLENKO 1977).

An interesting example of the short-term changes in the quantities of the morphological groups is the positive correlation between bacillus counts and the organic carbon content of water in 1977. Members of this group were possibly lifted from the sediment by storms, along with the organic carbon fractions. Another most interesting example is provided by the dynamics of colonial coccus-coccoid bacteria of both study periods. Reproductive activity of the population always increased on the day after a stormy one, that is, after a 20—24 hours lag period (Fig. 4). This was observed by OLÁH (1970), who concluded that bacteria were not carried up from the sediment to the water column, but in fact reproduced there. A further evidence for this hypothesis can be found by looking at the number of cells in the floating colonies bacteria. 80% of the colonies had cell numbers of some power of 2, indicative of active and synchronous cell division, and the growth of the colonies could be followed through samples of consecutive days.

The distribution of total bacterial counts mainly falls in the coccus-coccoid morphological group. Physiological tests would determine the species included in this group.

As successional processes, the close correlation between bacillus count and organic carbon content of the water, as well as the growth of colonial bacteria on the second and third day after a storm are similar to the laboratory observations. A study on the decomposition processes of reed chaff from Lake Balaton showed that bacillus populations increased an the first day, but soon broke down. On the second and third day minute cocci began to multiply and soon appeared in the water above the chaff and carried on multiplying (OLÁH 1972, 1973b). It would be interesting to know whether natural manifestation of this phenomenon was observed during the 1977 study period. However, it is not known whether the sedimental detritus stirred up by a storm can be considered analogous to reed chaff, since the former is already partially stabilized and cannot be further down under aerob conditions.

The following hypothesis explaining the increase in bacterial counts after storms is also plausible. HERODEK (1977 and pers. com.) carried out ^{14}C studies on phytoplankton production and found a paradoxial situation wherein algal reproduction increased over the years, but actual phytomass decreased. A possible reason for this occurrence comes from the chronic artificial fertilizer pollution of the lake. Since zooplankton production, thus the grazing pressure, has not increased parallely (PONYI 1977), elimination of phytoplankton is presumably brought about by the extreme variation in the physical properties of the water. Therefore, it is to be expected that the quantity of bacterioplankton will sharply increase to cope with the decomposition of dead algae. The results of this work show that the increase in bacterioplankton abundance in the large shallow Lake Balaton is brought about by the after-effect of the frequent stirring-up.

Estimates of bacterial generation time point to eutrophication processes since they are half of the 1973 estimates for the same season of the year OLÁH (1973b), indicating increased bacterial activity. It must be noted with respect to the method of estimation itself that, provided the abundance of bacterioplankton is always so well tracable, dynamic studies of undisturbed expanding colonies by frequent sampling would be the most reliable means of estimating generation time. This method would eliminate the need to extrapolate from studies carried out in closed vessels with all their shortcomings, like rapid changes in the dissolved gas and nutrient, contents in an enclosed space, glass effect, etc.

Summary

Short-term changes of the bacterioplankton of Lake Balaton were studied in relation to a number of measured parameters. Lake Balaton is a large, shallow lake with a number of inherent methodological problems. Changes in the numbers and biomass of coccus-coccoid, bacillus, diplococcus and spirillum morphological groups were monitored by daily sampling over one month in the summers of 1976 and 1977, respectively.

In both study periods total bacterial count was mainly distributed in the coccus-coccoid morphological group, 99% of which existed in floating colonies. In most cases the colonies contained cell numbers of synchronous division. In 1977 undisturbed growth of colonies was monitored to such a degree of precision that it was possible to estimate time in situ. Comparison with earlier data showed that generation time in the study area was reduced to half, indicating eutrophication. Reproductive activity of the coccus-coccoid population increased on the day after a storm, probably due to nutrient components, possibly dead algal masses, being released into the water by the stirred-up sediment. Results of a path analysis draw attention to the fact that the measured variables (algal phytomass, water temperature, wind velocity of the previous day) contributed only 47.3% to the total effect on the changes of bacterial counts.

Abundance and biomass of bacterioplankton was less in 1977 than in 1976, but compared with data of the preceding years, bacterioplankton shows a tendency to increase, thereby pointing to eutrophication. Organic carbon content measurements carried out in the study area for three consecutive years support this.

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MOSSES OF VIETNAM, I

By

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The list includes 107 species, six of which are new for Indochina, and five species are new for Vietnam. The studied specimens were deposited in Herbarium of the Hanoi University and in Eger-Vácrátót (EGR).

Introduction

During the years 1967—1974 the author was collecting mosses in various areas in Vietnam. A small part of these collections was identified by T. Pócs and other bryologists. The major part of them was deposited in the Herbarium of the Hanoi University (HANOI).

The author arrived in Hungary to continue postgraduate studies from 1978—1981. The author would like to give, as the first result of his studies, an account on the moss collections identified by himself until now.

The present and succeeding papers are intended to contribute to the knowledge of the Vietnamese bryoflora.

The enumeration comprises 107 species, many of which are interesting from phytogeographical point of view. 6 species are new for the whole of Indochina (indicated by ++ in front of the species' name), 5 species are new for Vietnam (indicated by + before the species' name).

Fissidentaceae

1. **Fissidens anomalus** Mont. — Tamdao: on tree, 950 m alt. above s. l. The author's collecting number: 69 100a. (Distr. Himalayas, India, Java, Ceylon, Burma, Thailand, Vietnam, Philippines and China.)
2. **Fissidens javanicus** Doz. et Molk. — Tamdao: on rock, 950, 69 196. (Distr. Himalayas, Burma, Thailand, Vietnam, Java, Borneo, Philippines and Malay Peninsula.)
3. **Fissidens mittenii** Par. — Tamdao: on soil, 900, 69 305. (Distr. Java, Burma, Sumatra, Singapore, Thailand, India, Vietnam, Ceylon and Borneo.)
4. **Fissidens nobilis** Griff. — Tamdao: on moist rock at streambad, 950, 69 269. (Distr. Himalayas, Burma, Thailand, Java, Borneo, Sumatra, New Guinea, Philippines, China, Hongkong, Vietnam, Indonesia and Japan.)
5. **Fissidens sylvaticus** Griff. — Tamdao: on tree trunks or on soils, 750—950, 68 207, 69 193, 69 257. (Distr. Himalayas, Assam, Burma, Java, Celebes, Borneo, Vietnam and Thailand.)

Ditrichaceae

6. **Garckea flexuosa** (Griff.) Marg. et Nork. — Tamdao: on soil, 950, 69 282. (Distr. Widely distributed in Asia, Central America and Australia.)

Dicranaceae

7. **Campylopus richardii** Schwaegr. — Tamdao: on soil, 900, 69 91. (Distr. Himalayas, India, Ceylon, New Guinea, Burma, Java, Borneo, Malay Peninsula, Sumatra, Philippines, Taiwan, China, Japan, Vietnam, Hawaii, Central and South America.)
8. **Dicranella coarctata** (C.M.) Bosch. et Lac. — Tamdao: on soils, 900—1000, 69 163, 69 268, 69 288, 69 351a. (Distr. Ceylon, Peru, Java, Taiwan and China.)
9. **Dicranodontium didictyon** (Mitt.) Jaeg. — Tamdao: on soil, 950, 67 132b. (Distr. Himalayas, India, Burma and Vietnam.)
10. **Holomitrium griffithianum** Mitt. — Tamdao: on decaying wood, 950, 69 58. (Distr. Ceylon, India, Burma, Assam, Bhutan, China, Thailand, Vietnam, Taiwan and Japan.)
11. **Leucobryum bowringii** Mitt. — Tamdao: on tree trunks or on decaying woods, 800—1300, 68 265, 69 218a, 69 201, 69 220, 69 378. (Distr. Ceylon, India, Assam, Bhutan, New Guinea, Borneo, Taiwan, Philippines, Vietnam, Thailand and Japan.)
12. **Leucobryum chlorophyllosum** C. Muell. — Tamdao: on decaying woods or on tree trunks, 800—1200, 69 181, 69 261, 69 276, 69 287. Taynguyen (S. Vietnam) on decaying woods, 700, 74 67, 74 143. (Distr. Burma, Ceylon, Timor, Vietnam and Thailand.)
13. **Leucobryum javense** (Brid.) Mitt. — Tamdao: on bases of trees, 1200, 68 219, 68 226, 69 337. Sapa: on soil or on rock, 71 47, 71 60. (Distr. Ceylon, India, China, Laos, Vietnam, Thailand, Malay Peninsula, Java, Borneo, New Guinea, Philippines, Indonesia, Japan and Hongkong.)
14. **Leucobryum neilgherrense** C. Muell. — Tamdao: on decaying woods, or on bases of trees, or on rock 900—1200, 68 371, 69 158, 69 179, 69 191, 69 218, 69 251, 69 276, 69 379. Sapa: on base of tree, 1700, 71 34. (Distr. Japan, Korea, China, Philippines, Java, Celebes, Sumatra, Thailand, Cambodia, Vietnam, Burma, Ceylon and India.)
15. **Leucobryum sanctum** C. Muell. — Tamdao: on tree trunk, 950, 69 243. (Distr. Malay Peninsula, Vietnam, Borneo, New Guinea, Philippines, Samoa, Australia.)
16. **Leucobryum scalare** C. Muell. — Tamdao: on tree trunk, 800, 69 371. Taynguyen: on tree trunks, 700, 74 68, 74 160. (Distr. Ceylon, China, Burma, Japan, Korea, Taiwan, Philippines, Borneo, Vietnam, Thailand, Cambodia, Fiji and New Guinea.)
17. **Leucoloma crispatum** Tix. — Tamdao: on bark of tree, 1000, 68 189. (Endemic to Vietnam.)
18. **Leucoloma molle** (C. Muell.) Mitt. — Tamdao: on bark of trees, 950—1350, 68 130, 68 247, 68 293. (Distr. Japan, Taiwan, China, Philippines, Malay Peninsula, New Guinea, Indonesia, Thailand, Cambodia and Vietnam.)
19. **Leucoloma taylorii** (Schwaegr.) Mitt. — Taynguyen: on tree trunk, 600, 74 07. (Distr. Ceylon, Burma, Nepal, Thailand, Vietnam and Cambodia.)
20. +**Ochrobryum kurzianum** Hamp. — Taynguyen: on tree trunks, 600—700, 74 22, 74 25, 74 27, 74 128. (Distr. Ceylon, Burma and Thailand.)
21. **Trematodon tonkinensis** Besch. — Tamdao: on soil, 800, 69 390. (Endemic to Vietnam.)

Calymperaceae

22. +**Arthrocormus schimperii** (Dz. et Molk.) Doz. et Molk. — Taynguyen: on bark of tree, 700, 74 71. (Distr. Ceylon, Java, Philippines, Assam, Malay Peninsula, Cambodia, Thailand, Borneo, Ambon, Queensland, Pacific Islands.)
23. ++**Calymperes vriesei** Besch. — Tamdao: on tree trunk, 700, 69 323. (Distr. Java, Celebes, Samoa, India.)
24. **Leucophanes octoblepharoides** Brid. — Tamdao: on bark of trees, 950, 68 151, 69 259. (Distr. This species widely distributed from Nepal to the Pacific Islands.)
25. **Octoblepharum albidum** Hedw. — Tamdao: on bark of trees, 900, 69 183a, 69 191. Tay-

nguyen: on tree trunks in dry *Dipterocarpaceae* forest, 700, 74 94, 74 106, 74 180, 74 181, 74 143, 74 152. (Distr. Pantropical.)
26. **Syrrhopodon japonicus** (Besch.) Broth. — Tamdao: on tree, 1300, 68 212. (Distr. China, Japan and Vietnam.)

Pottiaceae

27. **Hyophyla involuta** (Hook.) Jaeg. — Sapa: on rocks, 1600, 71 100, 71 110. (Distr. Cosmopolitan.)
28. **Pseudosymblepharis angustata** (Mitt.) Chen. — Sapa: on rock, 1700, 71 12. (Distr. Temperate to subtropical areas of Asia.)

Funariaceae

29. **Funaria hygrometrica** Hedw. — Tamdao: on soil, 1000, 68 390. (Distr. Cosmopolitan.)

Bryaceae

30. **Brachymenium exile** (Doz. et Molk.) Bosch. et Lac. — Tamdao: on tree, 900, 69 242. (Distr. Java, Taiwan, Korea, Japan, Hawai, India, Philippines, Ceylon and Sumatra.)
31. **Brachymenium nepalense** Hook. — Sapa: on tree trunks, 1700, 71 26, 71 107. (Distr. Himalayas, India, China, Taiwan, Ceylon, Borneo, Thailand, Sumatra, Celebes, Japan, Vietnam and Central Africa.)
32. +**Bryum billardieri** Schwaegr. — Tamdao: on rocks, 900, 69 139, 69 140. (Distr. Pantropical.)
33. ++**Bryum erythrocarpum** Schwaegr. — Tamdao: on bark of tree, 1350, 68 338. (Distr. Europe, Africa, Taiwan and Japan.)

Bartramiaceae

34. **Philonotis mollis** (Doz. et Molk.) Mitt. — Tamdao: on soil, 950, 69 351. (Distr. Himalayas, India, Japan, Thailand, Taiwan, Madagascar, Ceylon, Borneo, Philippines, Sumatra, Celebes and Vietnam.)

Orthotrichaceae

35. **Macromitrium japonicum** Dz. et Mb. — Tamdao: on twigs of trees, 900—1350, 69 3, 69 164, 69 165, 69 169, 69 185, 69 204, 69 239, 69 334. (Distr. Vietnam, Japan and China.)
36. ++**Macromitrium ferriei** Card. et Thér. — Tamdao: on twigs of trees, 900, 69 95. (Distr. Japan, Korea.)
37. **Macromitrium nepalense** (Hook. et Grev.) Schwaegr. — Tamdao: on twigs of trees, 900—1350, 68 166, 68 196, 69 331, 69 120, 69 296. Sapa: on tree, 1700, 68 72. (Distr. China, Hongkong, Thailand, Cambodia, Nepal, Sikkim, Burma, Malay Peninsula, Ceylon, Philippines and Vietnam.)
38. **Schlotheimia purpurascens** Par. — Tamdao: on twigs of trees, 900, 66 177, 68 138. (Distr. China and Vietnam.)

Rhacopilaceae

39. **Rhacopilum schmidii** C.M. — Tamdao: on trees, or on rocks, 900—1350, 67 153, 68 345, 69 12, 69 50, 69 128, 69 264, 69 253, 69 304, 69 313. (Distr. China, Thailand, Cambodia, Philippines, India and Vietnam.)

Cryphaeaceae

40. **Pilotrichopsis dentata** (Mitt.) Besch. — Tamdao: on bases of trees, 1000, 69 293a, 69 361. Sapa: on trees, 1700, 71 14, 71 15, 71 72. (Distr. Japan, China, Taiwan and Vietnam.)

Pterobryaceae

41. **Calyptothecium crispulum** (Bosch. et Lac.) Broth. — Sapa: on bark of trees, 1700, 71 15, 71 72. (Distr. Java, Thailand, Luzon, New Guinea, Philippines, Sumatra, Nepal and Vietnam.)
42. **Calyptothecium urvilleanum** (C. Muell.) Broth. — Tamdao: on bark of trees, 1350, 68 370, 68 386. (Distr. New Guinea, China, Nepal, Ceylon, Burma, Indonesia, Philippines, Java, Taiwan, Samoa and Vietnam.)
43. **Calyptothecium wrightii** (Mitt.) Fleisch. — Tamdao: on tree trunks, 900, 69 35, 69 39. Taynguyen: on trees, 700, 74 9, 74 52, 74 55, 74 154. (Distr. Ceylon, Burma, Nepal, Thailand, Laos, China, Taiwan and Vietnam.)
44. **Garovaglia elegans** (Doz. et Molk.) Bosch. et Lac. — Tamdao: on tree trunks, 950, 68 140, 69 96, 69 97. (Distr. Ceylon, Assam, Nepal, Bhutan, Burma, Laos, Thailand, Indonesia, Philippines, Taiwan, Singapore, Malay Peninsula, Samoa and Vietnam.)
45. **Garovaglia powellii** Mitt. — Tamdao: on tree trunks, 900—1200, 68 179, 69 89. (Distr. China, Ceylon, Nepal, Laos, Thailand, Malay Peninsula, Samoa and Vietnam.)
46. **Pterobryopsis orientalis** (C. Muell.) Fleisch. — Tamdao: on rocks, 900, 68 371, 69 91. Sapa: on rocks, 1700, 68 16, 68 18, 68 76, 68 77, 71 7. (Distr. Himalayas, China, India, Assam, Thailand and Vietnam.)

Meteoriaceae

47. **Aerobryopsis subdivergens** (Broth.) Broth. — Tamdao: on stems or on twigs of tree, 900—1350, 68 166a, 68 200, 68 361, 68 362, 68 283, 68 365. (Distr. China, Japan, Taiwan and Vietnam.)
48. **Aerobryopsis wallichii** (Brid.) Fleisch. — Tamdao: on stems or on twigs of trees, 900—1350, 68 158a, 68 301, 68 353, 68 355, 68 357, 68 358, 68 359, 68 392. (Distr. Himalayas, China, Ceylon, India, Indonesia, Philippines, Thailand, Malay Peninsula, New Guinea, Hawaii and Vietnam.)
49. **Aerobryum speciosum** Doz. et Molk. — Tamdao: on twigs of trees, 1350, 69 98, 69 119. Sapa: on tree, 1700, 71 15. (Distr. China, Himalayas, India, Java, Thailand, Borneo, Taiwan, Japan and Vietnam.)
50. +**Barbella enervis** (Thait. et Mitt.) Fleisch. et Broth. — Sapa: on bark of trees, 1700, 68 37, 71 96. (Distr. China, Taiwan, Ceylon, India, Himalayas, New Guinea, Philippines, Australia, Thailand.)
51. **Barbella flagellifolia** (Card.) Nog. — Tamdao: on twigs of trees, 1350, 68 201, 69 49, 69 90. Sapa: on twigs of trees, 1700, 68 90, 68 94, 68 96. (Distr. Ceylon, Java, India, Burma, Thailand, Sumatra, Borneo, Philippines, Taiwan, Japan and Vietnam.)
52. **Barbella spiculata** (Mitt.) Broth. — Tamdao: on stems or on twigs of trees, 900—1300, 67 143, 67 138, 68 287. Sapa: on stem of tree, 1700, 71 48. (Distr. India, Ceylon, Himalayas and Vietnam.)
53. **Chrysocladium retrosum** (Mitt.) Fleisch. — Sapa: on stem of tree, 1700, 68 106. (Distr. India, China, Ceylon and Vietnam.)
54. **Meteoriopsis reclinata** (C. Muell.) Fleisch. et Broth. — Tamdao: on twigs of living trees, 700—1300, 68 300, 68 366, 68 376, 69 346, 69 359. Sapa: on twigs of trees, 1700, 68 09, 68 11, 68 48, 68 105, 68 107. (Distr. Himalayas, India, China, Thailand, Laos, Java, Ceylon, Philippines and Vietnam.)

55. **Meteoriopsis squarrosa** (Hook.) Fleisch. et Broth. — Tamdao: on twigs of trees, 900—1000, 74 288, 74 232. (Distr. Himalayas, Nepal, Khasia, India, Thailand, Ceylon, New Guinea, Philippines, Malay Peninsula, Indonesia, Java and Vietnam.)
56. **Meteorium miquelianum** (C. Muell.) Fleisch. et Broth. — Sapa: on twig of tree, 1700, 68 36. (Distr. Tropical and subtropical regions of Asia.)
57. **Meteorium subpolytrichum** (Besch.) Broth. — Tamdao: on twigs of trees, 900—1350, 68 158, 68 203, 68 172, 69 55, 69 78, 69 106, 69 293c, 69 360, 69 359a, 69 390. Sapa: on twigs of trees, 1700, 68 13, 68 106, 68 104, 71 18. Distr. Nepal, China, Taiwan, Japan, Ceylon, Philippines and Vietnam.)
58. **Papillaria feae** Fleisch. — Sapa: on stems of trees, 1700, 68 29, 68 40, 68 103. (Distr. Himalayas, India, Burma, Thailand, Ceylon and Vietnam.)

Phyllogoniaceae

59. **Horikawaea nitida** Nog. — Tamdao: on bark of tree, 900, 69 247. (Distr. Taiwan, Assam, India, China and Vietnam.)

Neckeraceae

60. **Himantocladium plumula** (Nees.) Fleisch. — Tamdao: on trees, 1000, 68 312a, 69 107, 69 387. Taynguyen: on trees, 700, 74 47, 74 76, 74 197, 74 101. (Distr. Burma, India, Taiwan, Japan, Australia, New Guinea, New Caledonia, Thailand, Cambodia, Java, Borneo and Vietnam.)
61. **Homaliadelphus targionianus** (Mitt.) Dix. — Tamdao: on bark of trees, 1000,69 362, 74 225. (Distr. India, China, Japan, Thailand and Vietnam.)
62. **Hydrocryphaea wardii** Dix. — Tamdao: on rocks in stream, 900, 69 338, 69 339, 69 340, 69 342. (Distr. Assam and Vietnam.)
63. **Neckera pennata** (L.) Hedw. — Tamdao: on rock, 900, 68 371b. Sapa: on rocks, 1700, 68 02, 68 52, 68 74, 68 99, 71 98. (Distr. Cosmopolitan.)
64. **Neckeropsis andamana** (C.M.) Fleisch. — Taynguyen: on trees, 700, 74 43, 74 59, 74 132. (Distr. India, Burma, Ceylon, Andama, Thailand, Java, Philippines and Vietnam.)
65. **Neckeropsis lepineana** (Mont.) Fleisch. — Tamdao: on trees or on rocks, 800—900, 69 16, 69 42, 69 56, 69 73. (Distr. India, China, Madagascar, Ceylon, Thailand, Sumatra, Borneo, Celebes, Australia, Cameron, tropical. Africa and Vietnam.)
66. **Neckeropsis semperiana** (Hpe. et C.M.) Touw. — Tamdao: on bases of trees, 900, 67 158, 69 249. (Distr. Mindanao, Thailand, Luzon and Vietnam.)
67. **Pinnatella ambigua** (Lac.) Fleisch. — Tamdao: on rocks, 900—1000, 67 140, 67 152, 67 162a, 69 16, 69 53, 69 87, 69 86, 69 72, 69 73a. (Distr. Himalayas, Burma, India, Thailand, Java, Sumatra, Philippines and Vietnam.)
68. **Pinnatella anacamptolepis** (C.M.) Broth. — Tamdao: on rocks or on bases of trees, 900, 67 134, 69 94, 69 254. (Distr. Ceylon, Sumatra, Thailand, Japan, Philippines and Vietnam.)
69. **Pinnatella donghamensis** Besch. — Tamdao: on decaying woods, 900, 69 349, 69 350. (Endemic to Vietnam.)
70. **Pinnatella microptera** (C. Muell.) Fleisch. — Tamdao: on trees, 900, 68 289, 69 317, 74 240, 74 242. (Distr. India, Singapore, Malay Peninsula, Borneo, Philippines and Vietnam.)

Daltoniaceae

71. **Cyatophorella tonkinensis** (Broth. et Par.) Broth. — Tamdao: on rock, 900, 74 246. Sapa: on rock, 1700, 71 54. (Distr. China, Taiwan, Japan, Thailand and Vietnam.)

Hookeriaceae

72. **Callicostella papillata** (Mont.) Mitt. — Tamdao: on rock, 900, 68 302. (Distr. India, China, Japan, Thailand, Ceylon, Malay Peninsula, Sumatra, Java, Borneo, New Guinea, Philippines, Samoa, Madagascar and Vietnam.)
73. **Callicostella prabaktiana** (C.M.) Jaeg. — Tamdao: on rocks, 900, 68 329, 69 336. (Distr. Java, Borneo, New Guinea, Philippines, Malay Peninsula, Thailand, New Caledonia and Vietnam.)
74. ++**Distichophyllum osterwaldii** Fleisch. — Tamdao: on tree, 900, 68 136. (Distr. Java, Philippines, Japan.)
75. **Hypopterygium aristatum** V.d.B. et Lac. — Tamdao: on base of tree, 900, 68 334a. (Distr. Himalayas, Japan, Java and Vietnam.)
76. **Hypopterygium tenellum** C.M. — Tamdao: on rocks, 1000, 67 137, 67 146a. (Distr. India, Japan, Thailand, New Guinea, Cambodia, Ceylon, Borneo, China, Sumatra, Celebes, Philippines and Vietnam.)
77. **Hypopterygium vietnamicum** Pócs — Sapa: on rock, 1700, 71 89. (Endemic to Vietnam.)
78. **Hypopterygium vriesei** V.d.B. et Lac. — Tamdao: on rocks or on barks of trees, 900, 67 152a, 69 261, 74 221. (Distr. Java, Sumatra, Philippines, New Guinea, Ceram and Vietnam.)

Theliaceae

79. **Fauriella baolocensis** Tix. — Taynguyen: on tree, 700, 74 71a. (Endemic to Vietnam.)

Leskeaceae

80. **Pseudoleskeopsis zippelii** (Doz. et Mb.) Broth. (Syn.: *Pseudoleskeopsis annamensis* Broth. et Par.) — Tamdao: on rock, 900, 67 150. (Distr. Himalayas, India, New Guinea, Sumatra, Indochina, Java, Thailand, Borneo, Amboina, Philippines, China, Taiwan, Japan, Korea and Soviet Far East.)

Rhegmatodontaceae

81. **Rhegmatodon declinatus** (Hook.) Brid. — Tamdao: on tree, 900, 69 95a. (Distr. Nepal, Khasia, Burma, Thailand, Vietnam and China.)

Thuidiaceae

82. **Anomodon tonkinensis** Besch. — Tamdao: on rocks, 900, 69 14, 69 15, 69 144. (Endemic to Vietnam.)
83. **Haplocladium microphyllum** (Hedw.) Broth. — Sapa: on rock, 1700, 71 99. Tamdao: on rocks, 900, 69 20, 69 33, 69 36, 69 131, 69 127, 69 155, 69 170, 69 171, 69 324, 69 363. (Distr. Sikkim, India, China, Taiwan, Korea, Japan, Thailand, S. and N. America, Europe and Vietnam.)
84. **Thuidium cymbifolium** Dz. et Mb. — Tamdao: on rocks, on bases of trees or on decaying woods, 900—1100, 67 162, 67 163, 68 137, 68 187, 69 268. Sapa: on rocks, 1700, 68 12, 68 100a. (Distr. Himalayas, India, New Guinea, Korea, Japan, Thailand, Ceylon, Burma, Malay Peninsula, Java, Celebes, Philippines and Vietnam.)
85. **Thuidium glaucinoides** Broth. — Tamdao: on rocks, 900, 69 218. Sapa: on bark of tree or on rock, 1700, 68 41, 68 74. (Distr. Samoa, China, Taiwan, Japan, Burma, Thailand, Cambodia, Malay Peninsula, Sumatra, Java, Philippines and Vietnam.)

86. **Thuidium glaucinum** (Mitt.) Bosch. et Lac. — Tamdao: on decaying woods or on rocks, 900, 67 132, 67 172, 68 316a, 69 180. Sapa: on rock, 1700, 71 23. (Distr. Himalayas, India, China, Korea, Taiwan, Thailand, Ceylon, Malay Peninsula, Java, Sumatra, Philippines, Japan and Vietnam.)

Brachytheciaceae

87. +**Eurynchium vagans** (Jaeg.) Bertr. — Tamdao: on rocks, 900, 68 372, 68 375. Sapa: on rocks, 1700, 68 12a, 68 75. (Distr. Himalayas, India, China, Korea, Taiwan, Thailand, Ceylon, Malay Peninsula, Java, Sumatra, Philippines, Japan and Vietnam.)
88. **Pleuropus luzonensis** Broth. — Tamdao: on bark of tree, 900, 69 100. (Distr. Japan, China, Taiwan, Java, Philippines and Vietnam.)
89. **Rhynchostegium celebicum** (Lac.) Jaeg. — Tamdao: on bark of tree, 1000, 69 405. (Distr. Japan, Sumatra, Thailand, Celebes, Java, Malay Peninsula and Vietnam.)

Entodontaceae

90. **Campylodontium flavescens** V.d.B. et Lac. — Tamdao: on tree, 900, 68 371. Taynguyen: on bark of trees, 700, 74 04, 74 29. (Distr. Africa, Himalayas, India, China, Khasia, Laos, Burma, Ceylon, Thailand, Malay Peninsula, Indonesia, Philippines, Qeensland and Vietnam.)
91. **Entodon plicatus** C.M. — Tamdao: on tree trunk, 900, 69 83, 69 84, 69 124, 69 160, 74 227. (Distr. Himalayas, Ceylon, Celebes, India, China, Burma, Philippines and Vietnam.)
92. **Erythrodontium julaceum** (Hook.) Par. — Tamdao: on tree trunks, 900—1200, 69 27, 69 72, 69 148, 69 150, 69 161. Taynguyen: on tree, 700, 74 31b. (Distr. Paleotropical.)
93. **Trachyphyllum inflexum** Gepp. — Taynguyen: on bark of trees, 700, 74 13, 74 30, 74 33, 74 206. (Distr. India, Nepal, Khasia, Sikkim, Burma, Ceylon, Thailand, Cambodia, New Guinea, Java, Philippines, New Caledonia, tropical Africa and Vietnam.)

Plagiotheciaceae

94. ++**Plagiothecium euryphyllum** (Crd. et Thér.) Iwats. — Tamdao: on decaying woods, 1300, 69 311b, 68 266. (Distr. Japan, Taiwan and Korea.)

Hypnaceae

95. **Ectropothecium annamense** Thér. — Taynguyen: on moist rocks, 700, 74 65, 74 82. (Endemic to Vietnam.)
96. **Ectropothecium buitenzorgii** (Bel.) Jaeg. — Tamdao: on rocks, 900, 68 145, 68 184. (Distr. China, Sumatra, Borneo, Ceram, Thailand, Java, Celebes, Amboina, Cambodia, Philippines and Vietnam.)
97. **Ectropothecium monumentorum** (Duby.) Jaeg. — Tamdao: on rocks, 900, 69 293, 74 222. (Distr. China, Sumatra, Java, Thailand, Malay Peninsula, Borneo, Timor, Philippines and Vietnam.)
98. **Isopterygium albescens** (Mitt.) Jaeg. — Tamdao: on decaying woods, 1000, 68 171, 68 229, 68 230. (Distr. Java, Nepal, Sikkim, Khasia, Japan, China, Himalayas, Thailand, Cambodia, Borneo, Celebes, Philippines, Ceylon and Vietnam.)
99. **Isopterygium minutirameum** (C. Muell.) Jaeg. — Tamdao: on decaying woods or on tree trunks, 900—1200, 68 123, 69 183a, 69 222, 69 288, 69 290, 69 327. Taynguyen: on rock, 600, 74 114. (Distr. China, Japan, Ceylon, Sumatra, Borneo, Australia, Java, Thailand, Cambodia and Vietnam.)

100. **Isopterygium pohliaecarpum** (Sull. et Lesq.) Jaeg. — Tamdao: on soils, 900, 69 65, 69 369. (Distr. India, China, Taiwan, Malay Peninsula, Borneo, Samoa, Philippines and Vietnam.)
101. **Taxiphyllum chaetomitriodes** Tix. — Tamdao: on rock, 900, 69 233. (Endemic to Vietnam.)
102. **Taxiphyllum taxirameum** (Mitt.) Fleisch. — Tamdao: on rocks, 900—1000, 69 13, 69 41, 69 359d, 74 239, 74 243. (Distr. Himalayas, India, Taiwan, China, Japan, Malay Peninsula, Philippines and Vietnam.)
103. **Vesicularia reticulata** (Dz. et Mb.) Broth. — Tamdao: on rocks or on bases of trees, 900—1100, 68 141, 68 277, 68 334, 68 175, 69 344, 69 393, 69 354, 74 238, 74 241. (Distr. Nepal, Sikkim, China, Japan, Khasia, Singapore, Sumatra, Thailand, Java, Philippines and Vietnam.)

Polytrichaceae

104. ++**Oligotrichum javanicum** Dz. et Mb. — Tamdao: on soil, 900, 68 377. (Distr. Java.)
105. **Pogonatum macrophyllum** Dz. et Mb. — Sapa: on soil, 1700, 68 34, 68 47. (Distr. Himalayas, Khasia, Burma, China, Thailand, Cambodia, Malay Peninsula, Celebes, Sumatra and Vietnam.)
106. **Pogonatum neesii** (C. Muell.) Mitt. — Tamdao: on soils, 900—1350, 69 44, 69 71, 69 76a, 69 282, 69 289, 69 380. (Distr. Himalayas, India, China, Taiwan, Japan, New Guinea, Korea, Ceylon, Burma, Thailand, Java, Borneo, Philippines and Vietnam.)
107. **Rhacelopus pilifer** Dz. et Molk. — Tamdao: on soil, 900, 69 386. (Distr. Borneo, Java, Amboina, Philippines, New Guinea, Thailand, Sumatra and Vietnam.)

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CORRELATION BETWEEN THE VERTICAL LIGHT AND PHOTOSYNTHETICAL PIGMENT STRUCTURE OF A MULTILAYER COMMUNITY (TURKEY-OAK FOREST)*

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The correlation in a summer and early autumn aspect was studied between the distribution of relative light intensity (light structure) and the photosynthetic pigment concentration and pigment content (pigment structure) in the case of the creating species of the main producent layer in a *Quercetum petraeae-cerris* community. In all types of pigments (chlorophyll a, b, chlorophyll a + b, carotenoids, total pigment) except the autumn chlorophyll a — there was a most significant close correlation between the vertical distribution of the relative light intensity and the photosynthetical pigment concentration (mg/g) in both aspects. Based on this we can speak about common light—pigment structure. Chlorophyll a is in much less connection with light than the other pigments. The autumn rise of the correlation of carotenoids with light is striking. There is no significant correlation between the relative lighting and the distribution of pigment content (mg/dm^2).

Introduction

The total assimilative foliage of the multilayer plant community and the photosynthetic apparatus localized in it, change depending on the stratifical features of the community there is set structure. The vertical distribution of the photosynthetic pigments has a special role in every stand, and it should be in close connection with the light conditions, the light structure determined by the current community architecture.

Articles dealing with the vertical distribution of chlorophyll — as DUDA and KOLEK (1970) — are based on such considerations, but this refers to the only unilayer stand. OKUBO, OIZUMI, HOSHINO and NISHIMURA (1968) already described the correlation between the vertical distribution of light intensity and chlorophyll content, but they also referred to a unilayer community. We have extended our investigations to a more complex vertically larger forest — community and besides the chlorophyll — considering their importance — to the total spectrum of the photosynthetic pigments (all of the carotenoids). In our model area in the turkey oak forest (JAKUCS 1973) the pigment structure was investigated (TUBA 1977), and to a certain extent the supraindividual regulation of the pigments is known (FEKETE and TUBA 1977), and based upon the relative light examinations we have described the detailed light-structure of the community, too (TUBA, DARAI, NAGY and VITÁNYI 1980). Knowing the light and pigment structure we should like to indicate the correlation between them, with the help of the characteristic vertical profile.

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Material and methods

The model-area is a *Quercetum petraeae-cerris* stand of sprout origin, whose stratific conditions can be shortly characterized as follows. The average height of the canopy layer is 17—18 m, and consists of *Quercus petraea* and *Quercus cerris*. The main mass of the canopy layer is between 5—15 m high. The shrub layer separates into an above 1 m upper shrub layer (*Acer campestre*, *Acer tataricum*, *Cornus mas*, etc.) and a below 1 m lower shrub layer (*Euonymus verrucosus*, *Cornus sanguinea*, *Ligustrum vulgare*, etc.). The dominant species of the herb layer (average height is 0.2 m) are: *Poa nemoralis*, *Melica uniflora*, *Carex montana*, *Carex michelii*, *Festuca heterophylla*, *Dactylis polygama*, etc.

The results of the photosynthetic pigment examination made in July and in the beginning of September in the vegetation period 1976 (TUBA 1977) were used of the light structure examination in the 1977 vegetation period (TUBA, DARAI, NAGY and VITÁNYI 1980). The turkey oak's structure has considerable stability in the average of many years, and so the results of the pigment and light structure examination — made in the two different years and the radiation examination conducted since 1974 prove this stability. According to the radiation measurements above and in the forest at 2 m high during the main vegetation period, from the complete development of the foliage (in the beginning of May) to its autumn disintegration (in the beginning of October) there is a well expressed radiation structure, which can be regarded as permanent (NAGY 1976). The pigment gradient increasing downwards has likewise the same feature in all three years.

The pigment values used in our calculation, were defined by thin-layer chromatography from 20 leaves from every species with repetitions. The leaves were taken from the most varied light exposition, age and hight parts of the individuals. In summer 3, in autumn 4 repetitions were made.

In the 1977 vegetation period the light measurements were recorded on approximately uniformly clouded days, and 5 different places were marked for every layer. The measurements took place always on the marked, strictly fixed places, at the same time in the different layers with photoelectric light measuring (JU 16). At the same time the light intensity above the forest was measured and compared with the different values measured within the forest and expressed in per cent. The measurement of light intensity above the forest was carried out on the top of the 26 m hight instrument tower set up in the model area. According to the physiognomic structuring of the stand light measurements were made besides on the canopy layer, high and low shrub layer and herb layer on five places with different expositions of the stand (e.g. on the soil under the low shrub, above the low shrub, etc.). The relative light intensity values were based upon the data of 130 measurements referring to each layer.

We carried out correlation investigations between the photosynthetic pigment concentrations of the dominant species representing the different layers and the relative light intensity values characteristic of the layers. We also examined the correlation in the total vertical cross section of the community. The tables containing the basic data give only the average values in the case for the pigments (Tables 1—6) and the relative light intensity, too (Table 7). In our calculation we used only the values of the repetitions individually. The pigment values of the examined species of the layers were coordinated with the light intensity values characteristic of the different layers. The light intensity data characteristic of the layers and the pigment data of the layer creating species were coordinated three times choosing the light and pigment values occasionally. The correlation data were analysed separately with the three series of data pairs, as also the correlation between the main pigment components (chlorophyll a, chlorophyll b, chlorophyll a + b, total carotenoids = caratenoid components together, total pigment = chlorophyll-a + b + total carotenoids) and the relative light intensity, in summer and in early autumn, too. With the above mentioned method the correlation examinations were carried out between the relative light intensity and the pigment content referring to the area of dm^2, also. The non-linear correlation examination was extended to exponential and power function (SVÁB, 1973). The relative light intensity and the photosynthetic pigments can be described with a power function, because of the exponential feature of their vertical distribution (where the dependent Y variable is the pigment, the independent X variable is the light). The correlation coefficient values of the correlation examination — carried out with the three different serious of data pairs — were referred it to the summerly aspect in Table 8 and referring to the early autumn aspect in Table 9.

Table 1

Values of chlorophyll concentrations in the dominant species of the stratas of forest

Species	Chlorophyll a, mg/g		Chlorophyll b, mg/g		Chlorophyll a + b, mg/g	
	Summer	Autumn	Summer	Autumn	Summer	Autumn
Canopy layer:						
Quercus cerris	1.753	0.976	0.466	0.297	2.119	1.276
Quercus petraea	1.287	1.214	0.490	0.591	1.778	1.806
Shrub layer:						
Acer campestre	2.479	—	0.945	—	3.424	—
Acer tataricum	3.355	0.621	1.038	0.624	4.393	1.245
Cornus mas	3.855	0.344	0.522	0.688	4.377	1.032
Cornus sanguinea	3.101	—	1.680	—	4.781	—
Euonymus verrucosus	3.319	1.185	1.589	1.669	4.808	2.827
Ligustrum vulgare	1.887	3.171	1.085	4.313	2.972	7.484
Herb layer:						
Carex montana	1.993	3.687	0.818	2.336	2.811	6.023
Melica uniflora	3.137	5.693	1.624	3.431	4.761	9.124
Poa nemoralis	2.312	—	1.082	—	3.394	—

Table 2

Values of carotene concentrations in the dominant species of the stratas of forest

Species	Carotene, mg/g		Lutein + anteraxanthin, mg/g		Violaxanthin, mg/g		Neoxanthin, mg/g	
	Summer	Autumn	Summer	Autumn	Summer	Autumn	Summer	Autumn
Canopy layer:								
Quercus cerris	0.252	0.210	0.212	0.274	0.290	0.049	0.143	0.063
Quercus petraea	0.257	0.241	0.196	0.319	0.639	0.161	0.160	0.121
Shrub layer:								
Acer campestre	1.225	—	0.361	—	0.822	—	0.189	—
Acer tataricum	1.280	0.468	0.563	0.479	0.662	0.234	0.118	0.243
Cornus mas	1.035	0.325	0.576	0.560	0.990	0.228	0.564	0.145
Cornus sanguinea	0.462	—	0.738	—	1.411	—	0.279	—
Euonymus verrucosus	0.625	0.648	0.937	0.887	0.933	0.396	0.319	0.424
Ligustrum vulgare	0.416	0.224	0.500	0.563	0.879	0.550	0.240	0.270
Herb layer:								
Carex montana	1.003	0.964	0.419	1.245	0.486	0.834	0.200	0.558
Melica uniflora	1.257	1.545	0.162	2.175	0.229	0.852	0.311	0.975
Poa nemoralis	0.441	—	0.002	—	0.732	—	0.224	—

Table 3

Values of total carotenoid concentrations and total pigment concentrations in the dominant species of the stratas of forest

Species	Total carotenoid concentration mg/g		Total pigment concentration mg/g	
	Summer	Autumn	Summer	Autumn
Canopy layer:				
Quercus cerris	0.897	0.596	3.016	1.872
Quercus petraea	1.252	0.842	2.030	2.651
Shrub layer:				
Acer campestre	2.597	—	6.021	—
Acer tataricum	2.623	1.424	7.016	2.669
Cornus mas	3.165	1.258	7.542	2.290
Cornus sanguinea	2.890	—	7.671	—
Euonymus verrucosus	2.814	2.391	7.622	5.218
Ligustrum vulgare	2.035	1.607	5.007	9.091
Herb layer:				
Carex montana	2.108	3.601	4.919	9.624
Melica uniflora	1.959	5.548	6.720	14.672
Poa nemoralis	1.399	—	4.793	—

Table 4

Values of chlorophyll content in the dominant species of the stratas of forest

Species	Chlorophyll-a		Chlorophyll-b		Chlorophyll-a + b	
	mg/dm²					
	Summer	Autumn	Summer	Autumn	Summer	Autumn
Canopy layer:						
Quercus cerris	0.913	0.518	0.242	0.157	1.155	0.675
Quercus petraea	0.723	0.718	0.280	0.353	1.003	1.071
Shrub layer:						
Acer campestre	0.801	—	0.304	—	1.105	—
Acer tataricum	0.931	0.216	0.288	0.209	1.220	0.425
Cornus mas	0.886	0.104	0.120	0.160	1.006	0.264
Cornus sanguinea	0.896	—	0.487	—	1.383	—
Euonymus verrucosus	0.756	0.252	0.374	0.367	1.130	0.619
Ligustrum vulgare	0.650	1.006	0.373	1.375	1.023	2.381
Herb layer:						
Carex montana	0.510	0.819	0.209	0.535	0.719	1.353
Melica uniflora	0.772	0.653	0.407	0.382	1.179	1.035
Poa nemoralis	0.669	—	0.314	—	0.983	—

Table 5

Values of carotenoid content in the dominant species of the stratas of forest

Species	Carotene		Lutein + anteraxanthin		Violaxanthin		Neoxanthin	
	mg/dm²							
	Summer	Autumn	Summer	Autumn	Summer	Autumn	Summer	Autumn
Canopy layer:								
Quercus cerris	0.131	0.111	0.112	0.144	0.262	0.026	0.075	0.033
Quercus petraea	0.145	0.143	0.168	0.189	0.345	0.094	0.080	0.072
Shrub layer:								
Acer campestre	0.394	—	0.118	—	0.266	—	0.061	—
Acer tataricum	0.357	0.156	0.156	0.156	0.185	0.078	0.047	0.022
Cornus mas	0.309	0.076	0.133	0.131	0.229	0.054	0.132	0.035
Cornus sanguinea	0.132	—	0.215	—	0.432	—	0.081	—
Euonymus verrucosus	0.150	0.150	0.222	0.196	0.211	0.087	0.075	0.094
Ligustrum vulgare	0.143	0.071	0.172	0.175	0.315	0.176	0.083	0.084
Herb layer:								
Carex montana	0.257	0.230	0.109	0.297	0.127	0.203	0.051	0.136
Melica uniflora	0.314	0.172	0.037	0.244	0.066	0.096	0.077	0.109
Poa nemoralis	0.131	—	0.001	—	0.215	—	0.065	—

Table 6

Values of total carotenoid content and total pigment content in the dominant species of the stratas of forest

Species	Total carotenoid content mg/dm²		Total pigment content mg/dm²	
	Autumn	Summer	Summer	Autumn
Canopy layer:				
Quercus cerris	0.580	0.314	1.735	0.989
Quercus petraea	0.748	0.498	1.751	1.569
Shrub layer:				
Acer campestre	0.839	—	1.944	—
Acer tataricum	0.745	0.412	1.965	0.837
Cornus mas	0.803	0.296	1.809	0.560
Cornus sanguinea	0.860	—	2.243	—
Euonymus verrucosus	0.658	0.527	1.788	1.146
Ligustrum vulgare	0.713	0.506	1.736	2.887
Herb layer:				
Carex montana	0.544	0.866	1.263	2.219
Melica uniflora	0.494	0.621	1.673	1.656
Poa nemoralis	0.412	—	1.395	—

Table 7

Average values of relative light intensity of stratas (I/I_0)

Layers	%
Canopy layer	63.7
High shrub layer	12.3
Low shrub layer	7.7
Herb layer	6.2

Table 8

Correlation coefficients between vertical distribution of relative light intensity (I/I_0) and vertical distribution of photosynthetical pigments (mg/g). Summer

Degrees of freedom: 30			
Chlorophyll-a	0.4790**	0.4576**	0.4945**
Chlorophyll-b	0.6859***	0.6548***	0.6568***
Chlorophyll-a + b	0.6195***	0.5967***	0.6197***
Total carotenoids	0.4851**	0.4754**	0.4692**
Total pigments	0.5992***	0.5787***	0.5899***

** Significant at 1% level
*** Significant at 0.1% level

Table 9

Correlation coefficients between vertical distribution of light intensity (I/I_0) and vertical distribution of photosynthetical pigments (mg/g). Autumn

Degrees of freedom: 32			
Chlorophyll-a	0.2999	0.3208	0.3001
Chlorophyll-b	0.7764***	0.7920***	0.7735***
Chlorophyll a + b	0.5595***	0.5822***	0.5654***
Total carotenoids	0.7459***	0.7635***	0.7470***
Total pigments	0.6930***	0.7125***	0.6977***

*** Significant at 0.1% level

Results and discussion

Considering the correlation-coefficients of the connection between the vertical distribution of the relative light intensity and the photosynthetic pigment concentration — described with a power function — we can find out that in both aspects there is significant correlation in all the pigment compo-

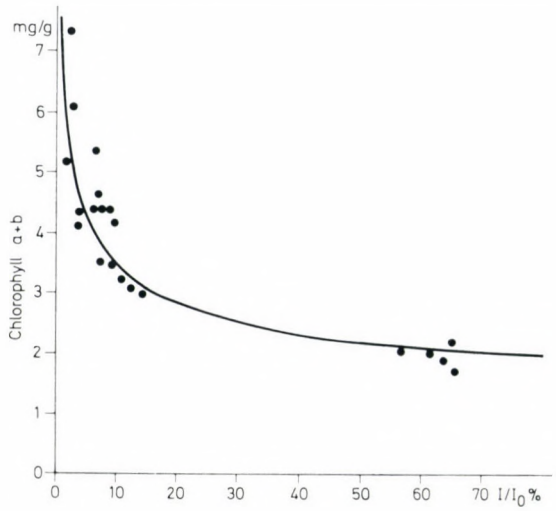

Fig. 1. Correlation between relative light-intensity and the total chlorophyll concentration. Summer $Y = 7.0427\ X^{-0.2941}$; $r = 0.6197^{***}$

nents — except the autumn chlorphyll-a (Tables 8, 9 and Fig. 1). The summer chlorophyll-a and the total carotenoid concentration at $P = 1\%$ level and in all the other cases the pigments at $P = 0.1$ level are significant to the relative light intensity. In summer the chlorophyll-a has much less connection with light, for all this is totally absent in autumn. These facts refer to the importance of the other pigments. In the lower layers the chlorophyll-b and the carotenoids have assumed an ever more important role in contrast with chlorophyll-a. Under the effect of the intensity decreasing and spectral changes of the light filtering through the canopy layer, declines the central physiological role of chlorophyll-a. In consequence of this chlorophyll-b, total chlorophyll and the carotenoids have a closer connection with the light conditions than chlorophyll-a as reflected by the correlation coefficients. This change in the pigment structure is more expressed in autumn reflecting first of all the autumn periodical changes of radiation conditions, at this time. The most conspicuous is a marked increase in the carotenoids correlation with light and chlorophyll-a has not shown significant correlation, already.

No significant connection was found between the vertical distribution of relative light intensity and the vertical distribution of the pigment content (mg/dm^2). This corresponds to the earlier results of a pigment structure analysed without correlating and according to this increase of the pigment concentration corresponds with the vertical decrease of light intensity, but the pigment content does not. This problem includes — first of all — the anatomical and biochemical combined effects of light. We should like to make a detailed analysis of the weight/surface rate, light and pigment quantities.

The close correlation of the vertical light structure and pigment structure in a multilayer community makes reasonable use of the expression of combined light-pigment structure. The pigment structure is formed in the vertical combined light pigment structure as a function of the determining light conditions; in our case according to the described correlations.

ACKNOWLEDGEMENTS

We express our sincere thanks to Prof. G. FEKETE for his valuable advice. The calculations were carried out in the Computer Centre of the BESSENYEI Gy. Teachers' College, for which we are most grateful.

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CYTOPHOTOMETRIC DNA STUDIES IN POLYPLOID SERIES OF THE FERN GENUS *CYSTOPTERIS* BERNH.

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Cytophotometric measurements of DNA/cell values were obtained on Feulgen stained G_2 nuclei of the *Cystopteris fragilis* polyploid fern complex. Di-, tri-, tetra-, penta-, hexa-, and octoploid samples were studied. The observed DNA values correspond to the expected increased amount of DNA, due to polyploidization. In spite of the very high level of polyploidy, we could not find negative deviations from the expected amount of DNA, either because of elimination or inactivation of the obviously redundant genetic material.

Introduction

Polyploidy, the duplication or multiplication of entire genomes is a process of great evolutionary importance. Its primary effect is the stabilization of heterozygosity and hybrid vigour which may be the reason for its rapid colonization (STEBBINS 1950; LEWIS 1967). At the same time, alloploid combinations are usually reproductively isolated from their progenitors (DE WET 1971). In this way, a population exhibiting divergent adaptive norm can develop which is the first step towards sympatric species formation (LÖVE 1964). At the same time, polyploid taxa possessing enhanced ecological amplitude increase the probability of the survival of the species complex. On the other hand, by ageing of the complex, the parental diploids have become restricted in area, eventually leading to extinction. During subsequent polyploidizations, the number of species diminishes within the complex, and only high polyploids (multigenomic alloploids) characterized by the mean of the properties of the diploid species will survive (VIDA 1973, 1976). Such an advanced polyploid complex will finally consist of a few old polyploid taxa, each with broad tolerance but with strongly decreased genetic variance (STEBBINS 1971).

Genome multiplication does not change the ratio of regulator and structure genes (OHNO 1970). On the other hand, homozygotic loci (with four identical genes in a tetraploid) and many heterozygotic ones where heterozygosity has not proved to be superior, represent unnecessary redundancy. Natural selection will tend to eliminate these supernumerary genes, consequently the amount of DNA decreases.

Among plants, GRANT (1969) and his co-workers (e.g. TAPER and GRANT 1973) studied DNA contents in polyploid series of *Betula*. There was a reduction of the relative DNA amount compared to the expected values, in polyploids. However, the total genomic chromosome length appeared to be constant.

High ploidy level has already been recorded in several primitive vascular plants (MANTON 1950; CHIARUGI 1960; FABBRI 1963, 1965; STEBBINS 1966). The most extensive development of successive cycles of polyploidy is known in the subclass *Ophioglossidae*, which is believed to be one of the most primitive living taxon of the class *Filicopsida* (true ferns).

The lowest basic number of the taxon is x = 45 (*Botrychium*). The genus *Ophioglossum* can be regarded as an old polyploid complex of which the recent basic number is x = 120 (paleo-polyploid, sensu CHIARUGI 1960), and contains di-, tetra-, hexa-, octoploid, and approximately dodecaploid species. According to CHIARUGI (1960) the recent "diploid" species of *Botrychium* can be regarded as paleohexaploids, based on x = 15, while the "lowest" 2n chromosome number of *Ophioglossum* (2n = 240) could well be a paleo-16-ploid. The highest cytotypes

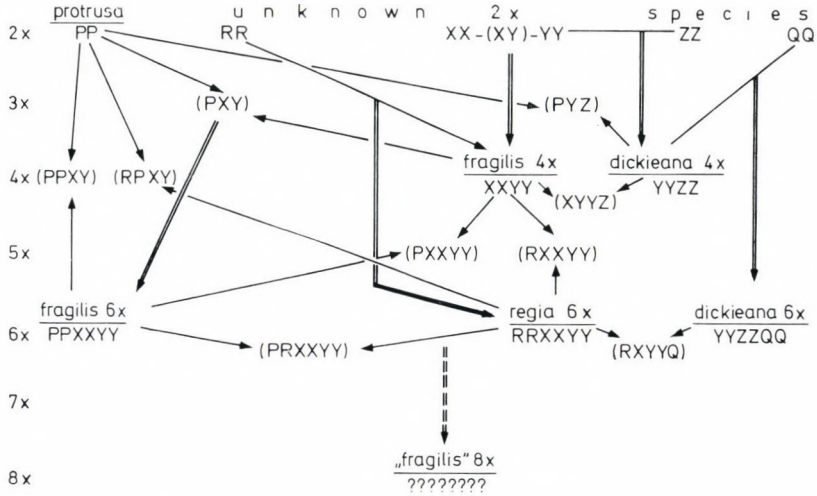

Fig. 1. Genomic relationships within the *Cystopteris fragilis* complex

actually reaching c. 84-ploidy. All these species exhibit relatively small chromosomes. As the other extremes, contemporary species of subclass *Osmundidae* are all diploid (n = 22). Like species of *Hymenophyllum*, they have conspicuously large chromosomes, having increased nuclear DNA content without altering the number of linkage groups.

Chromosome numbers and genomic relationships have been clarified in most European fern species — subclass *Filicidae* (MANTON 1950; CHIARUGI 1960; VIDA 1972, 1973; LOVIS 1977). Chromosomes of both di-, and polyploid fern species are often equally small. It is not clear therefore, that the amounts of DNA/cell in polyploids correspond to the expected value or significantly deviate towards a decreased value as—in the case of *Betula* polyploids.

We have chosen the genus *Cystopteris* in order to study the relationship between ploidy level and the nuclear DNA content. *Cystopteris fragilis* exhibits an extensive polyploid complex, with partly clarified genomic relationships (VIDA 1973, 1974): Fig. 1. Available living material with various polyploid level (up to 8x) offered an opportunity for this study.

Material and methods

Investigated *Cystopteris* taxa, grown in the experimental garden of the Botanical Institute, Hungarian Academy of Sciences, are listed in Table 1.

DNA measurements in root meristem nuclei at G_2 (just before mitotic division) were made using FEULGEN cytophotometry on M 85 Vickers microdensitometer. Root tips were

Table 1

Origin and genome symbol of various members of Cystopteris fragilis complex used for the present cytophotometric measurements

Species	Ploidy level	Genome symbol*	Specimen Nr.	Origin
C. protrusa	2x	PP	50	USA, Oakland county, Michigan (TR 880)**
C. bulbifera	2x		44	USA, Tuscola county, Michigan (TR 879)**
C. fragilis	4x	XXYY	3	Hungary, Mátra Mts., Sombokor
			52	Roumania, Hargita Mts.
	6x	PPXXYY	11	Hungary, Bükk Mts., Füzérvár
			6, 16	Czechoslovakia, Belansky Tatry Mts.,
			10, 20	Roumania, Bucegi Mts., Diham
	8x	?		
C. regia	6x	RRXXYY	1, 34	Roumania, Retezat Mts., Jorgovan
C. dickieana	4x	YYZZ	55	Spain, Sierra Nevada (TR 916)**
	6x	QQYYZZ	8	USA, Alpena county, Michigan (TR 878)**
			9	Greenland, Rosenborg glacier**

* According to VIDA, 1974.
** Living plants obtained from Prof. T. REICHSTEIN (Basel).
*** Fertile fronds were collected by A. J. ALLEN (1971) and sent to us by A. C. JERMY (British Mus. Nat. Hist.). Plants have been raised from spores in Budapest.

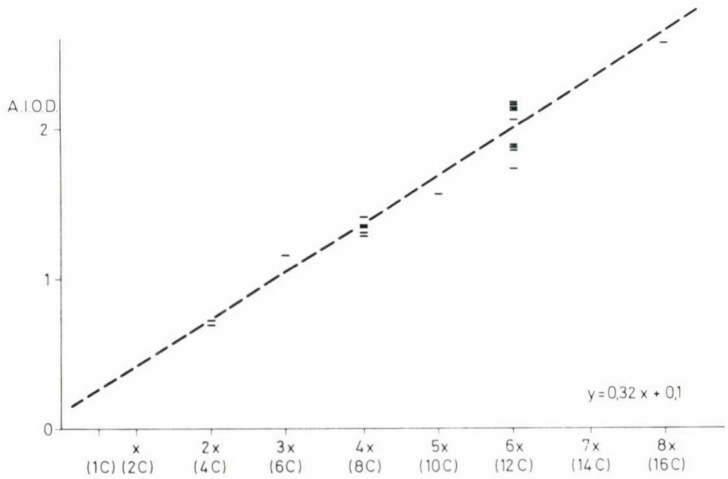

Fig. 2. Absolute integrated optical density (A.I.O.D.) values as a function of ploidy level in *Cystopteris fragilis* complex. (For numerical data see Table 2)

fixed in ethanol — acetic acid (3 : 1), and FEULGEN stained according to the classical procedure with a modified hydrolysis time (SHARMA and SHARMA 1972).

The arbitrary densitometer values were calibrated into absolute integrated optical density (A.I.O.D.) units, calculated with instrumental constants. Data are given with standard error values of sample means. 15—30 nuclei were measured in two parallel root tips of each series.

Results

The results are summarized in Table 2, and Fig. 2. They include mean DNA readings of the G_2 root meristeme nuclei in absolute integrated optical density (A.I.O.D.) together with standard error values.

Data of some available synthetic or collected *Cystopteris* hybrids are similarly presented here for comparisons within the genus.

Table 2

Average DNA values (G_2) of Cystopteris plants in absolute integrated optical density units, with standard error of sample mean ($s_{\bar{x}}$)

Species	Ploidy level	Specimen	$\bar{x}$ (A.I.O.D.)	$s_{\bar{x}}$
C. protrusa	2x	50	0.69	0.02
C. bulbifera	2x	44	0.73	0.02
C. fragilis (4x)×*C. protrusa* (2x)	3x	38	1.16	0.01
C. fragilis	4x	3	1.29	0.04
		52	1.41	0.03
C. dickieana	4x	55	1.36	0.04
C. fragilis (4x)×*C. dickieana* (4x)	4x	42	1.31	0.02
C. dickieana (4x)×*C. fragilis* (4x)	4x	35	1.36	0.03
C. fragilis (4x)×*C. dickieana* (6x)	5x	43	1.57	0.05
C. fragilis	6x	11	1.86	0.04
		6	2.06	0.05
		16	2.17	0.04
		10	2.16	0.04
C. dickieana	6x	8	2.16	0.03
		9	1.89	0.04
C. dickieana (6x)×*C. fragilis* (6x)	6x	27	2.17	0.08
C. regia	6x	1	2.14	0.02
		34	1.85	0.01
C. dickieana (6x)×*C. regia* (6x)	6x	21	1.73	0.06
C. fragilis	8x	20	2.57	0.06

Discussion

Average nuclear DNA contents of diploid species ($G_2 = 4C$) are 0.69 A.I.O.D. (*C. protrusa*) and 0.73 (*C. bulbifera*), respectively. Although only one of these species belongs to *Cystopteris fragilis* complex (*C. protrusa*), these values do not differ significantly.

The majority of plants examined here are hexaploid. This ploidy level appears to be presently optimal for the complex in Europe. Both the tetra- and hexaploid taxa are allopl ɔid. The origin of octoploid *C. fragilis* is still to

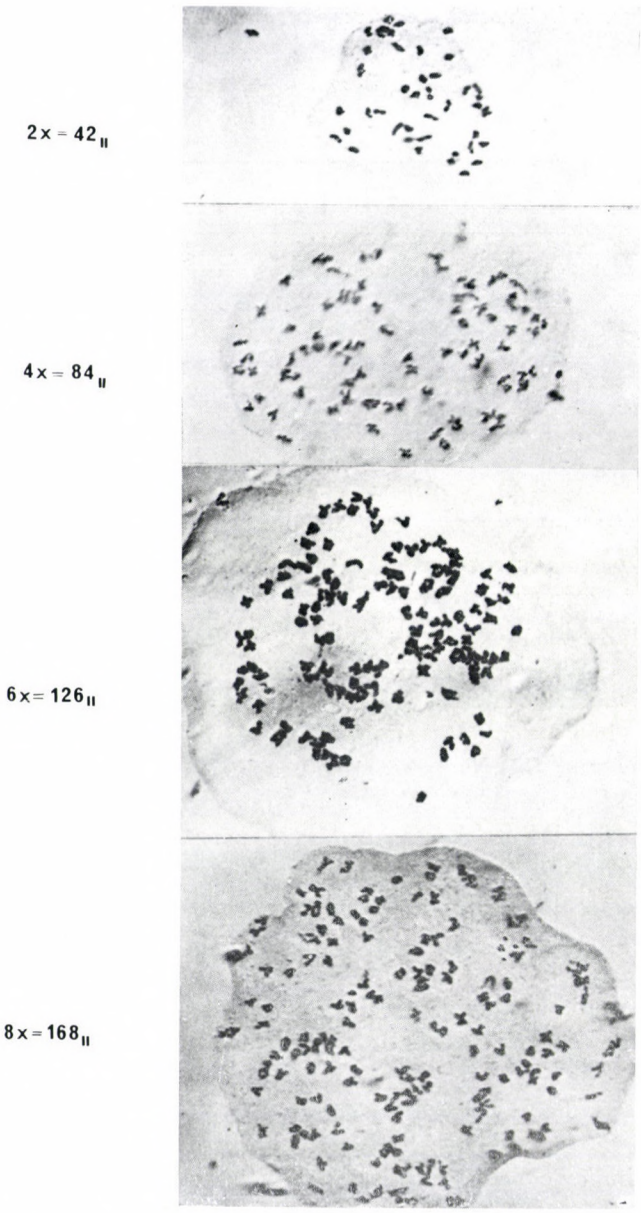

Fig. 3. Meiosis in the polyploid series of *Cystopteris fragilis* (×600): 2x — *C. protrusa* (USA, TR 880), 4x — *C. fragilis* (Hungary, Mátra Mts., Sombokor), 6x — *C. fragilis* (Roumania, Bucegi Mts., Diham), 8x — *C. fragilis* (Roumania, Bucegi Mts., Diham)

be clarified (VIDA 1974, 1976). Although an auto-allo genomic composition cannot be excluded, there is no sign of multivalent formation at meiosis in spite of the high chromosome number (Fig. 3).

The hexaploid DNA content values ($G_2 = 12C$) of different genome compositions are given in Table 3. Each species (s. str.) possesses two Y genomes.

Table 3

Average DNA values (G_2) of hexaploid Cystopteris species

Species	Genome symbol*	Mean A.I.O.D. (12 C)
C. fragilis	PPXXYY	1.99
C. regia	RRXXYY	2.00
C. dickieana	QQZZYY	2.03

* According to VIDA 1974.

In addition, *C. regia* and *C. fragilis* share two more genomes (XX). Chromosomes of the original diploid genomes have not diverged very much in the polyploids, since they show regular pairing in hybrids of species with at least one common genome (VIDA 1974).

Comparisons in species hybrids lead to the conclusion that DNA amounts are determined by ploidy level alone. Consequently we may presume similar DNA amounts of the ancient, parental diploid species. Our data seem to contradict previous cytophotometric results obtained in some flowering plants. TAPER and GRANT (1973), VERMA and REES (1974), BARLOW and NEVIN (1976) investigating species of *Betula*, *Brassica* and *Luzula* species, showed significant decrease in relative DNA content in polyploids as compared with the expected polyploid values, without accompanying detectable cytological alterations (total chromosome length). Chromosome volume shows a linear relationship with DNA content, in conformity with the "quantitative karyology" of BARLOW and NEVIN (1976). VERMA and REES refuse the claim that a substantial DNA diminution has taken place in polyploids. Measuring DNA/cell values of newly synthesized allotetraploids, and correcting for the modified density, they propose to explain the observed decreased absorbance without actual DNA loss. The change may be due to "switching off" of redundant gene copies in the tetraploid complement by altering the packaging of DNA.

Partly similar conclusions have been reached by GARCIA-OLMEDO et al. (1978) in the allohexaploid wheat. Searching chromosomal locations of genes encoding biochemical systems, they admit that probably both inactivation and losses of redundancy have taken place in the evolution of this polyploid.

Our cytophotometric measurements do not indicate substantial decresae in optical density of the polyploid nuclei, therefore do not support any of the above hypotheses in the *Cystopteris* polyploid complex.

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RECENSIONES

A. F. DYER (Editor): The Experimental Biology of Ferns. Academic Press, London, New York, San Francisco, 1979. XVIII + 657 p.

This book is interesting not only for pteridologists but also for biologists working in many other fields. Fern as an experimental system often provides a unique possibility being extremely suitable for genetic, morphogenetic, cytological, cytochemical, cytogenetic, physiological or even autecological studies. The poor species-repertory of yesterday's experimental biology will certainly be enriched considerably due to the stimulus given by this book.

A. F. DYER's edition is Volume 14 of "Experimental Botany, an International Series of Monographs" (consulting editor J. F. SUTCLIFFE). This volume is of high quality, with several illustrations. Beside the Introduction (by J. HESLOP-HARRISON), various aspects of fern biology are described in 15 chapters.

Another likewise successful volume on ferns (The Phylogeny and Classification of the Ferns, Academic Press, 1973) has been published recently (eds A. C. JERMY, A. H. CRABBE and B. A. THOMAS), to which the present volume of A. F. DYER seems to be complementary. The former is dealing mainly with comparative taxonomical aspects, while DYER's volume — as the title suggests — contains chapters mainly on various experimental approaches. This distinction, however, is not an absolute one since some parts of the book is strictly descriptive, particularly the very first chapter, entitled "The Diversity of Ferns. An Ecological Perspective", by C. N. PAGE. Nevertheless, this chapter is also useful for the experimental biologist, since with the knowledge of the ecological requirements of the species concerned, one can appropriately design the experimental conditions. The following (3rd, 4th and 5th) chapters, however, are of a more unequivocally experimental approach.

Ferns are especially suitable for the examination of changes in life cycles, due to the independent gameto- and sporophytic generations. P. R. BELL's chapter provides information on this aspect. T. G. WALKER's chapter is a concise summary of the ample literature on the questions of fern cytogenetics. He emphasizes the more general features. E. J. KLEKOWSI, Jr. presents the newest fields of pteridology under the title "The Genetics and Reproductive Biology of Ferns". (Earlier genetical studies appear to be often difficult for modern interpretation. By intragametophytic mating of homosporous ferns using *in situ* bioassay systems, it is possible to test the effects of environmental mutagens.

Two further chapters contain ultrastructural descriptions. D. C. CRAN analyses the young gametophyte; J. M. PETTITT deals with the formation of the spore wall.

The editor of the book is the author of Chapter 8, in which useful practical advices are given with regard to the setting up of fern gametophyte cultures and to the methodology for carrying out experiments with them. DYER is also coauthor (with M. A. L. KING) of Chapter 9, in which the regularities and consequences of prothonemal cell divisions are described. The subject of Chapters 10—13 is again the gametophyte since its simple structure has several advantages ower the more complex sporophyte. The morphogenesis of the gametophyte from a biochemical-physiological aspect is summarized by D. L. SMITH; light regulation by G. P. HOWLAND and M. E. EDWARDS. Antheridium development and the hormonal or pheromon-type regulation of the antheridium is described by U. NÄF, while P. R. BELL discusses the ultra-structural details of gametogenesis and of fertilization.

Relatively limited space has been allotted in the volume for the examination of the morphogenesis of the sporophyte (R. A. WHITE's concise chapter takes only 47 pages in contrast with the nearly 430 pages part on the gametophyte). The volume closes with C. N.

PAGE's compilation entitled "Experimental Aspects of Fern Ecology" and the chapter on applied biology (The Bracken Fern; its Biology and Control) by W. W. FLETCHER and R. C. KIRKWOOD.

A carefully compiled species and subject index completes the volume. A. F. DYER's book is warmly recommended to every researcher and institute dealing with experimental biology. The reader less acquainted with pteridology will soon realize the unique advantages of ferns as experimental systems. Since the publication of F. VERDOORN's "Manual of Pteridology" in 1938 it is DYER's present volume, together with "The Phylogeny and Classification of the Ferns" mentioned in the introduction, that will offer great assistance in studies of pteridophyte biology.

G. VIDA

ALEXANDER, M. (ed.): Advances in Microbial Ecology. I. Plenum Press, New York and London 1977. p. 268

This book is timely in a period when an ecological approach is becoming generally accepted. In spite of the human animal and plant aspects of ecosystems we have found only a few works dealing with the theoretical and methodological aspects of microbial ecology.

It is inconceivable that soil, water or air ecosystems could be understood or known without a detailed knowledge of microbial communities of different habitats. Microbial ecology has a lot of problems to solve. These could be enumerated as for example lack of modern methods of microbial analysis differentiating at species level and the demanding and tremendous work of complex analysis of microbial populations explaining why the number of real ecological publications on microbial ecology is so small.

The layout of the book is excellent with nearly 1000 citations 85 figures and 10 tables.

"The purposes of this review series are to present in, one group of volumes an overview of the information that is now spread in an enormous array of technical journals to have authors in various areas of microbial ecology summarize and present views in depth of their own specialities and to help promote the continued growth of microbial ecology. It is planned that reviews will deal with diverse ecosystems and processes including both basic and applied problems and all major categories of microorganisms — bacteria, fungi, algae, protozoa and viruses" as written by the Editorial Board in the Preface.

Among the five chapters the first dealing with: Detritus food chains of aquatic ecosystems: The role of bacteria (by T. M. FENCHAL and B. BARKER JORGENSEN) in which current knowledge on the role played by bacteria in the carbon cycle of ecosystems" is discussed the primary the anaerobic decomposition, the utilization of bacteria by animals and the quantitative importance of bacteria is detailed.

In the second chapter a general review is given by the famous specialist Prof. VELDKAMP on the "Ecological studies with the chemostat" on the basis of the experience of his school: nutrient limitation in algae, heterotrophic production in bacteria and about the very interesting problems relating to microbial interactions.

The title of the third chapter is "Microbial transformation in the phosphorus cycle". Here the transformation of phosphorus compounds in plant and animal remains is discussed on entering the soil, the mineralization and solubilization of phosphorus in the soil, its transformation in waste water treatment plants and inland basins and the microbial degradation of phosphorus containing insecticides.

On the basis of numerous (more than 400) citations a monograph has been given by D. D. FOCHT and W. VERSTRAETE about the old but very important problem nitrification and denitrification discussed from a biochemical ecological point of view: chemianthrophic heterotrophic nitrification, denitrification, the effect of environmental factors as well as their applied and environmental aspects.

J. W. M. LA RIVIERE is the writer of the last chapter dealing with a difficult problem namely the microbial ecology of liquid waste treatment: main characteristics of ecosystems encountered in biological waste treatment, microbial ecology of activated sludge systems, microbial ecology of trickling filters and anaerobic digestion microbial ecology of exudation ponds and also giving conclusions and perspectives.

The appropriate index provides easily accessible information. The book is useful for microbiologists working with the theoretical and practical problems of aquatic and terrestrial ecosystems and is a good source of knowledge for biologist and specialists who are not biologists, too.

We are looking forward to the next volumes of this series.

M. KECSKÉS

WALTER, H.: Vegetation of the Earth and Ecological Systems of the Geo-biosphere. Springer-Verlag, New York. 1979. 274 pp, 124 figures

The book is the second edition in English of the work which had already achieved three editions in German (Vegetationszonen und Klima. Die ökologische Gliederung der Biogeosphere).

In the author's Preface it is emphasized that with the demographic increase on earth and with urbanization the natural environment increasingly suffers damages. Moreover, with the increase in the pollution of air and waters, the physical and psychical health of man is in danger. Therefore, it is desirable and necessary to assess the natural environment still available for mankind.

The first two chapters of the book (Introduction: The Classification of Ecological Systems, General Section) presents the basic notions. From the climatic conditions of the geobiosphere, nine so-called zono-biomes can be distinguished. Each zono-biome has a given zonal soil and vegetation type. A transition between two zono-biomes is the zono-ecotone. The notions orobiome, pedobiome and biome are also discussed. A comprehensive picture of the structure of the ecosystem and of the material cycles is provided. The historical factor has an important role in the formation of the individual floral domains. In this introductory part also the types of WALTER's climate diagrammes, the climate diagramme map as well as the relationship between concurrence conditions and the environment, the ecotypes, etc., that is all the factors that have a part to play in the formation of the various vegetation types, are presented.

The chief part of the work consists of the 9 + 6 chapters in which the author describes in detail the following zono-biomes: Equatorial Diurnal Climate with Evergreen Tropical Rain Forest, Tropical Summer-Rain Region with Deciduous Forests, Subtropical Deserts, Winter-Rain Region and the Zono-ecotone Toward More Humid Zones, Warm-Temperate Humid Climate Region, Temperate-Nemoral Climate, Arid Temperate Climate, Cold Temperate Boreal Climate, Tundra Climate. In the individual chapters, detailed causal-ecological descriptions of vegetation types, of their eco-physiological characteristics, of the climatic and soil conditions as well as the orobiomes within climate zones are to be found. The excellent text is completed with very good illustration materials, figures and photographs representing the individual vegetation types. In six chapters the transitional zones, the so-called zono-ecotones are described (Semi-Evergreen Forest, Climatic Savannas, Semidesert, Forest-Steppe, Boreonemoral Zone, Forest Tundra).

In the closing chapter, the extension of the various vegetation zones, their phytomass and primary productivity are discussed.

The book has an extensive reference list as well as a specialized register.

To summarize it can be stated that the valuable work presents a good and clear picture of the earth's climatic, soil and vegetation zones, and it is an indispensable study for specialists dealing with environmental biology.

M. KOVÁCS

PEBERDY, J. F., ROSS, A. H., ROGERS, H. I., COCKING, E. C. (Editors): Microbial and Plant Protoplasts. p. XII + 370. Academic Press, London, New York, San Francisco, 1976.

Stripping cells from their wall-envelope seemed at the beginning to be only a cirious procedure but its importance became increasingly evident in the last twenty years as exemplified with the fascinating reports of the International Protoplast Symposia, the milestones of a world-wide intensive research work in this field (Jena 1964, Brno 1968, Salamanca 1972, Nottingham 1975).

The advantage of using protoplasts as starting material for the isolation of cell components is obvious as this is presently the most delicate method of desrupting cells. The analysis of the regeneration of a cell wall around protoplasts gives us data on the structure and synthesis of the cell walls. With the aid of protoplast fusion it is possible to produce hybrids between organisms which otherwise could not be brought together. Even very distant organisms can be mixed in this way (e.g. *Homo* and *Mus*, plants and animals etc.). Introduction of viruses, plasmids, mitochondria, plastids is possible into protoplasts, too. The first reports on the possibility of mixing foreign genetic materials caused alarm not long ago. At present it seems that the possible dangers have been a little overestimated, so performing protoplast fusions is now considered a proper method. Although some of the aims of the research have some sci-fi-like tones (e.g. incorporation of nitrogen-fixing genes into higher plants) such possibilities cannot a priori be excluded.

The volume reviewed here is the Proceedings of the Fourth International Symposium on Yeast and Other Protoplasts held in the University of Nottingham. England in September 1975. Each of the twenty reports included in the book is a round, clear, and intriguing record of data and problems connected with a special field. Isolation and properties of bacterial, yeast, fungal and higher plant protoplasts:

R. E. MARQUIS and T. R. CORNER: Isolation and Properties of Bacterial Protoplasts;

D. KERRIDGE et al.: The Production and Properties of Protoplasts from the Dimorphic Yeast *Candida albicans;*

J. F. PEBERDY: Isolation and Properties of Protoplast from Filamentous Fungi;

P. K. EVANS: Higher Plant Protoplasts: Isolation and Properties;

O. E. LANDMAN and MARIA R. DE CASTRO-COSTA: Reversion of Protoplasts and L-forms of Bacilli;

G. E. EDWARDS et al.: Photosynthetic Properties of Plant Protoplasts.

Synthesis of cell wall:

H. J. ROGERS et al.: Biosynthesis of Wall Polymers by Bacterial Protoplasts;

D. R. KREGER et MARIA KOPECKÁ: Assembly of Wall Polymers During the Regeneration of Yeast Protoplasts;

A. H. ROSE: Biogenesis of the Yeast Cell Envelope;

J. G. H. WESSELS et al.: Wall Synthesis by Fungal Protoplasts;

J. H. M. WILLISON: Synthesis of Cell Walls by Higher Plant Protoplasts.

Virus uptake by protoplasts:

F. E. YOUNG et al.: Surface Properties of Bacterial Protoplasts and L-forms that Influence Genetic Exchange and Viral Infection in Bacilli;

DIANE J. MITCHELL et al.: Virus Uptake and Interaction in Yeasts;

I. H. PALLETT: Interactions Between Fungi and their Viruses;

D. HESS: Uptake and Expression of Foreign Genetic Material in Plant Protoplasts.

Fusion of protoplasts:

L. FERENCZY et al.: Fusion of Fungal Protoplasts Induced by Polyethylene Glycol;

E. C. COCKING: Fusion and Somatic Hybridisation of Higher Plant Protoplasts.

The "natural" counterpart of protoplast fusion in bacteria and yeasts:

ELINOR MEYNELL: Sex Pili: Certainty and Conjecture;

MARJORIE CRANDELL: Mechanisms of Fusion in Yeast Cells.

The β-glucanases, enzymes for production protoplasts and having an important role in synthesis and growth of walls:

J. I. VILLANUEVA et al.: β-Glucanases in Nature.

The book is a very useful, thought provoking reading which can be warmly recommended to all interested in the pioneer work of modern biology.

J. ZSOLT

SWAIN, T., J. B. HARBORNE and C. F. V. SUMERE (eds): Biochemistry of Plant Phenolics. Recent Advances in Phytochemistry 12. Plenum Press, New York, London, 1979.

This volume — entitled "Proceedings of the first joint symposium of the Phytochemical Society of Europe and the Phytochemical Society of North America" — contains the lectures delivered at the Conference held in Rijkuniversitet Ghent Belgium in 1977. The 19 chapters on 651 pages provide the most important methodological, chemical, biochemical, etc. knowledge related to phenols, from the pen of internationally known specialists. It was an endeavour of the authors of the volume to illustrate the subject by examples taken mainly from their own field of research, and by literature overwhelmingly of most recent origin.

The chapters of the volume are as follows:

1. Recent Advances in the Separation of Plant Phenolics (C. F. VAN SUMERE, W. VAN BRUSSEL, K. VANTE CASTEELE and L. VAN ROMPAEY). This chapter presents the bibliographical elaboration of modern methods related to the separation of phenol-type chemicals, that is, gas-liquid chromatography and high performance liquid chromatography. The authors summarize in tables the literary sources related to the above methods, with an indication of the compounds analysed and the conditions of application of the methods.

2. Advances in the Spectroscopy of Plant Phenolics (V. M. CHARI, H. WAGNER). The chapter summarises the possibilities of application of modern spectroscopical methods (UV spectroscopy, Mass spectroscopy), ^{1}H-NMR spectroscopy, ^{13}C-NMR spectroscopy, by critically analysing the methods used in the field of phenolics.

3. The Shikimate Pathway (H. G. FLOSS). The main way of plant phenols coming into existence is the Shikimate Pathway, through which — among others — Chorismic Acid comes into existence. A great variety of phenol derivatives can be deduced from this compound. The biochemical — partly supposed — pathways of these transformations are described in this chapter.

4. An Introduction to the Enzymology of Phenylpropanoid Biosynthesis (K. R. HANSON, F. A. HAVIR). An important intermediary of the plant phenol derivatives, coming into existence from aromatic amino acids in the living organism. The enzymes of transformation from amino acids are Phenylalanine Ammonialyase (PAL), Cinnamata 4-hydroxylase, Phenolase. The characterization of these enzymes, the present stage of knowledge related to the effect of mechanism of enzymes are presented.

5. Recent Work on Cinnamoyl CoA Derivatives (M. H. ZENK). The chapter is closely linked with the preceding chapter, as for as it aims at the enzymatic analysis of the biosynthesis of phenols. This time a further step of biochemical processes, the conditions of coming into existence of the derivatives from intermediaries that have already been activated, of Cinnamoyl CoA, are reviewed.

6. Recent Advances in the Chemistry and Biochemistry of Lignin (G. G. GROSS). The construction, analytics and reactions of decomposition of lignins, as well as the structures characteristic of the greater taxonomical units of the vegetable kingdom, together with their differences, are described in this chapter. Several questions of the biochemistry of lignins are also put into the focus of discussion.

7. Selected Topics in Flavonoid Biosynthesis (H. GRISEBACH). The chapter presents the biosynthesis of flavonoids from the viewpoint of enzymology, first of all, on the basis of analyses in parsley cell cultures. The biosynthesis of flavonoids leads through chalconflavonon to the various other known derivatives (flavones, flavonols, anthocyanins). The questions of regulation in biosynthesis are discussed also from the viewpoints of enzymology.

8. Biochemistry of the Coumarins (S. A. BROWN). This bibliographical compilation concisely describes the biosynthesis of coumarines which leads to about 500 derivatives through the intermediary umbellipheron. Going beyond discussing the biosyntheses in plant coumarins, a separate subsection describes the effect on living cells of these compounds.

9. Recent Advances in the Chemistry and Biochemistry of Quinone Pigments (R. H. THOMSON). The quinones occurring in plants are formed by way of various biosyntheses. This review comprises mainly such compounds that have rarely occurring structures and the great majority of which are produced by microorganisms. The review deals separately with polycyclic quinones and heterocyclic quinones; within terpenoid quinones, with meroterpenoid quinones, sesquiterpenoid quinones and with diterpenoid quinones.

10. Biosynthesis of Gossypol (P. HEINSTEIN, R. WIDMAIER, P. WEGNER, J. HOWE). Gossypol is a compound belonging to the defensive mechanism of cotton, which — besides its phenolic character — owing to its biosynthesis can be considered as an isoprenoid derivative too. The authors discuss the way of biosynthesis of this compound on the basis of their own works.

11. Metabolism and Degradation of Phenolic Compounds in Plants (W. BARZ, W. HOESEL). In connexion with the metabolism of phenolic compounds, the authors emphasise the circumstance that decomposition may occur parallel with synthesis. The turnover rates of the compounds taking part in the biochemical processes are different, therefore a separate analysis of the individual compounds is an important momentum. The examinations related to metabolism are evaluated by the authors mainly from enzymological viewpoints.

12. Metabolism of the Aromatic Amino Acids by Fungi (C. K. WAT, G. H. N. TOWERS). In this chapter, the transformation of phenylalanin, tyrosin, tryptophan, and the building in of these compounds into secondary products of metabolism (e.g. into anti-biotics, pigments) are dealt with in the case of fungi. The description of various biochemical reactions, for example de-amination, de-carboxylation, etc., is also provided. The derivatives are described in 7 groups also in detail.

13. Oxidases in Aromatic Metabolism (V. S. BUTT). The summary deals primarily with the study of spinach-beet phenolase; this enzyme oxidises the para-substituted phenols into orthophenols, then into ortho-quinones. The role of phenolases is dealt with in general, from the viewpoint of the defensive mechanism of the injured cells is discussed by comparing the role of phenolase, laccase and of peroxidase enzymes.

14. Variation in and Functional Significance of Phenolic Conjugation in Plants (J. B. HARBORNE). The conjugate types of phenols occurring in plant cells are dealt with in a grouping of water-soluble and lipoid-soluble conjugates. Such data related to anthocyanins, flavonoids, phenol sulphates, etc. that refer to the origin and biological functions of them are described in more detail.

15. Vegetable Tannins (E. HASLAM). After the clarification of the notion of tannin, the distribution of tannins, their part played in the living world, their occurrences etc. are discussed. After grouping the various tannins according to structure, a more detailed description of the more known types are also presented.

16. The Physiology of Phenolic Compounds in Plants (J. W. McCLURE). This chapter deals primarily with the subcellular occurrence; with the questions of localisation (in vacuoles) and formation (in plastices). The effect of light, of some hormones in plant growth on phenol formation is discussed, and the possibilities of cell level analyses are critically evaluated.

17. Phenolic Substances and Plant Disease (J. FRIEND). In the interaction between plants and their parasites, phenol-type compounds play an important part. This chapter gives the evaluation of these interactions, deals with the question of resistance, the mechanism of protection in plants and points out the shortcomings of our knowledge related to this complex question.

18. Phenolic Compounds in Plants of Pharmaceutical Interest (H. WAGNER). The author starts from the point that every phenolic compound has — owing to its chemical structure — important biological effects, some of which can be utilised pharmaceutically. From the latter viewpoint, the author mainly deals with the flavonoid type compounds. On the basis of publications since 1975, the pharmacological place of phenolic compounds is assigned among the biologically active compounds of plant origin.

19. Phenolics in the Environment (T. SWAIN). This chapter deals with the ecological role of phenolic compounds, and discusses the environmental biological role of secondary metabolic products (e.g. antibacterial, inhibitory, repellent, etc. effects) from the viewpoint of adaptation and competition.

On the basis of the chapters presented in this review, this work is recommendable mainly to readers who wish to have an insight of the most recent research results related to plant phenols. The book can be of use for biochemists, plant chemists, chemotaxonomists, pharmacologists, biologists, etc. as well, who are interested in a modern summarising description of the biological functions of secondary metabolic products.

I. MÁTHÉ jr.

MUSSEL, M. and STAPLES, R. C.: Stress Physiology in Crop Plants, 1979, John Wiley and Sons, New York. 510 p.

This book edited by Mussel and Staples contains a collection of some papers presented at the International Conference on Stress Physiology in Crop Plants held in 1977. This symposium by the Rockefeller Foundation and the Boyce Institute for Plant Research aroused considerable interest, because the increased agricultural productivity under adverse environmental conditions and different stress situations are serious problems all over the world.

World population is predicted to almost double in the next 2 decades, world food needs have increased rapidly with population rise, so we have to improve food supplies, to expand agricultural areas cultivated presently, to develop methods in agriculture and for this we have to know more about the climatic environmental factors that limit yields and their adverse impacts on plants as well as the plants' response to environmental stress.

This book helps us to understand the stress effects on plants especially from a physiological standpoint and provides a comprehensive review of stress research. 21 papers delivered at the congress and published in this book include basic and applied information on temperature (heat, chilling, frost, freezing), ion stress (salinity, phosphate deficiency, aluminium toxicity), drought and physical stress, as well as air pollution effects on crop yields. A major part of the articles deals with rice, sorghum, potatoes, wheat, legumes and corn crops and with capability of resistance and adaptation of these plants. Some of the chapters providing the latest information, deal with the molecular basis of stress injuries to plants, water and heat stress effects on "C" metabolism, effects of freezing and cold acclimatization on membrane structure and function, as well as environmental perturbation on the growth of plants together with special anatomical changes.

In the first article CHRISTIANSEN gives a short general survey on organization and conduct of plant stress research. He describes the most important environmental factors limiting crop yields in tropical and temperate zones. The role of plant stress research in improving agricultural production and the research program including 6 points are explained in detail. CHRISTIANSEN emphasizes the significance of some research areas neglected so far such as genetic approach to mineral stress problems, root function, metabolic function, hormone systems disturbed by stress and manipulation of tissue culture to breed resistant plants.

MUSSEL and MALONE present a successful agricultural practice in reducing the impact of disease-induced stress on crop yields and discuss the advantages for the strategy of disease tolerance.

Four papers deal with the problems of ion stress. RHUE in this review article presents differential Al tolerance in crop plants. The effects of Al on plant growth, Al uptake by plants, facultative and obligate accumulator plants are demonstrated. Various mechanisms are presented to explain the differential Al tolerance of plant species, as well as the results of both genetic and biochemical studies of the mechanisms of Al tolerance. Varietal differences in Al tolerance are reported in detail in different crop plants such as in perennial ryegrass, soybeans, rice, potatoes and in wheat, barley, corn, alfalfa.

A comprehensive study on phosphate concentrations in soil solutions and the effect of this ion on crop plants are presented by FOX. Phosphorus and the soil-plant system, external P requirement of crops such as maize and the response of plant species to P concentration in solution as influenced by yield potential and by volume of soil fertilized are studied in many respects. In addition, the problems of P stress are approached in many ways. This survey is very useful from a practical point of view.

In the paper by SOMERS the influence of salinity upon germination of seeds, on growth of plants in different vegetative phases and the relationship of production of food plants with highly saline water are discussed. Moreover the problems and the prospects of selecting salt tolerant strains of conventional crops or domestication of wild halophytes are elaborated at length. PASTERNAK and TWERSKY's paper similar to SOMERS' article deals with crop behaviour under salinity. They focus their attention on studies of cotton and tomatoes with respect to the effect of salinity from physiological aspects.

Five papers presented in the book deal with the effects of temperature.

Freezing injury has already been known for a long time, but membrane damage of freezing has again received greater attention since the late 1960's. As to STEPONKUNS' opinion it is very important to understand the molecular basis of freezing damage to membrane structure and function also for understanding cold acclimatization. STEPONKUNS analyses at depth the effects of freezing on chloroplast tylakoids.

GUSTA and FOWLER study cold resistance and injury in winter cereals. Breeding for cold hardiness and the role of water in cold hardiness are also presented by them and some methods used in evaluating the cold hardiness of winter cereals are discussed.

Chilling injury is an other limiting factor in crop production that has received increased attention. The basic mechanisms involved in the temperature response to chilling are studied in LYONS' and BREINDENBACH's paper. Some strategies for altering chilling sensitivity in crop plants such as conditioning, chemical treatment, genetic manipulation are also presented by them.

BURKE and STUSHNOFF discuss frost damage and deep supercooling of water in terms of the molecular mechanisms. *Prunus* genus is used as an example to demonstrate mechanisms of deep supercooling leading to plant injury.

Breeding of potatoes for heat and frost resistance has been studied by the International Potato Center for a long time, and the results as well as the advances made in breeding are discussed in the article of MENDOSA and ESTRADA. They give a detailed review on the genetic resources and some tests for heat and frost resistance, too.

The following chapters are about the problems of drought resistance.

SULLIVAN and ROSS deal with selecting of *Sorghum* for drought. As to SULLIVAN 3 criteria could be used to evaluate drought resistance. The criteria are the following:

1. maintenance of high leaf water potentials;
2. stomatal control of diffusive resistance to water loss;
3. desiccation and heat tolerance.

It was also found that drought stress together with high temperature effects had a considerable influenced on the photosynthesis of *Sorghum*. Genotypes have been selected on the basis of the ability to photosynthesize at high temperatures.

Genetic improvement of drought resistance in *Sorghum* has been discussed by BLUM.

Drought stress as a major limiting factor to yields of tropical crops has been studied in Cowpea and Soybean by many researches. The results have been summarized by Wien, LITTLETON and AYANAGA. It was suggested that evaluation of drought resistance could be made on the basis of several characteristics, which were the following to mention some of them: rate of extension growth, leaf moisture potential, heat tolerance test by electrical conductivity, rate and extent of root growth.

The physiological basis of drought resistance has been examined in cereals by O'TOOLE and CHANGE. They also discuss the problems in breeding and selecting of rice for drought.

Testing and selecting for drought resistance in the case of wheat have been reported by TOWNLEY, SMITH and HURD.

The article written by JONES deals with stomatal behaviour with respect to breeding for drought resistance. Stomatal behaviour and the regulation of water loss, as well as the problems related to stomata have been analyzed in detail.

TURNER in his paper defines 3 types of drought resistance such as: drought escape; drought tolerance with high tissue water potentials; drought tolerance with low tissue water potentials. Within each mechanism of drought resistance and the influences of drought, as well as water deficits on photosynthesis, CGR and yield are summarized.

The effects of drought have been concerned with moisture stress. SHELDRAKE and SAXENA describe some of their observations on growth and development of Chickpeas under progressive moisture stress.

There has been relatively little work dealing with the effects of stress on metabolism, control of growth or reproductive process, so LAWLOR's article discussing the effects of water and heat stress in relation to C and N metabolism, photosynthesis, photorespiration of plants with C_3 and C_4 photosynthesis is most interesting and valuable.

Finally, the article on air pollution stress should be mentioned WEINSTEIN and McCUME give a good review on the kinds of air pollution damage to vegetation and the interaction of air pollution with other stresses.

This book is important from a theoretical aspect as well as a practical point of view. It will find a wide readership among agronomists, plant breeders, plant physiologists, genetists and environmentalists concerned with the problems of stress physiology.

K. VIRÁGH

SWAIN, T., WALLER, G. R. (eds) Topics in the Biochemistry of Natural Products. Recent Advances in Phytochemistry 13. Plenum Press, New York, London, 1979.

The volume has been compiled on the basis of the material of the "Proceedings of the first joint meeting of the American Society of Pharmacognosy and the Phytochemical Society of North America, held at Oklahoma State University, Stillwater, Oklahoma, August 14—17, 1978", and makes 253 pages divided into 8 chapters. The authors are renowned specialists of the given field of research. The editors grouped the above chapters by the following four topics: Stereochemistry of enzyme action; Alkaloids; Terpenoids; Marine natural products. The various chapter titles, referring to different research areas — occasionally lying far apart from each other — provide more information than those of the above grouping which are only too general in nature. An unambiguous link relating the various chapters to each other is the emphasis being placed on the enzymatic analyses and that they are used in the evaluation of the data obtained in the individual research areas. It should be emphasized that although part topics are discussed in the various chapters, the approach to the problems and the generalizations to be found in the individual chapters will provide useful reading also for specialists working in other areas of phytochemistry.

The chapter titles of the volume are as follows:

1. Are the Steric Courses of Enzymatic Reactions Informative About Their Mechanisms. (J. RETEY). In general, enzymatic reactions take place stereo-specifically. Starting from this point, the author expresses his convincement that stereochemical reaction analyses may contribute to the clarification of details unknown so far in the ways of bio syntheses. The importance of analysing stereochemically the biochemical processes is in this chapter illustrated by the use of isotope labelling for the reaction of certain enzymes as e.g. phenyl-pyruvate tautomerase, amino-methanol deaminase, or by B_{12}-catalyzed rearrangements. Attention is called to the importance of reflection-equivalent partial structures (enantiotopic groups or faces) within a molecule.

2. Stereochemical Studies on the Metabolism of Amino-Acids. (D. J. ABERHART.) In this chapter, the author aimed at analysing — by isotope labelling — certain part problems (ring closure of amino acids) related to the formation of the "penam" ring system in penicillin. On the basis of analyses of his own, the author succeeded in clarifying several part processes, or in presenting the probable course of the processes. In the second part of the chapter, the description of the catabolism of valine, and leucine, is presented also by taking into consideration stereochemical viewpoints.

3. Biosynthesis of the *Cephalotaxus* Alkaloids. (R. J. PARRY.) The biosynthesis of alkaloids, occurring in the *Cephalotaxus* species of the *Cephalotaxaceae* family and described in 1969, among them mainly that of cephalotaxine, is are dealt with in this chapter. The compilation gives an insight into supposed biosynthetic pathways of phenylalanine and tyrosine

from amino acids, and the formation of the ring system in cephalitoxin alkaloids. References to the biochemical derivation of some associate alkaloids, and to the formation of acid components of alkaloids that can be derived by the esterification of the central alkaloid (cephalotaxine). The chapter provides a good example of using isotope labelling methods. It should be mentioned that in the alkaloid group discussed there occur esteralkaloids of significant anti-leuchemical effect.

4. Enzymology of Indole Alkaloid Biosynthesis (K. M. MADYASTHA, C. J. COSCIA). The alkaloids of *Catharanthus roseus*, significant also from therapeutical viewpoints are synthesized from the triptophan amino acid and from the secologanin (iridoid) monoterpene compounds. The author examines from enzymological viewpoints mainly the conditions of monoterpene formation, the experiments linked with monoterpene hydrosylase and questions related to enzyme activity, occurrence and regulation. The chapter also includes analyses and hypotheses related to the activity of monoterpene alcohol oxidoreductase, loganic acid methyltransferase, strictosidine synthetase, β-glucosidase and cathenamine reductase enzymes. The latter enzymes are in connexion with the formation and further changes in the intermedier strictosidine, which can be considered as alkaloid.

5. From Terpenes to Sterols; Macrorevolution and Microrevolution (G. OURISSON, M. ROHMER, and R. ANTON). The chapter is divided into two well-separable parts. In the first part, the place occupied by terpenes (triterpenes, tetraterpenes) in macroevolution is discussed. The part played by these compounds in the stabilization of cell membranes, as well as the "development" of the compounds from the older tetraterpenes through hopanoids to triterpenes, and also the supposed scheme of enzyme changes together with the consequence of this in the biosynthesis pathway are described. In connexion with phylum development, several new theoretical considerations are reviewed. In the second part of the chapter, by using the terpene components of *Euphorbia* genus, the authors present an example of microevolution. The tracing is made possible by the variation in the terpene composition within the genus.

6. Regulation of Terpenoid Biosynthesis in Higher Plants (C. A. WEST, M. V. DUDLEY and M. T. DUEBER). The title of the chapter indicates in general the biosynthesis of terpenoids. The authors, however, deal mainly — beyond the reviewing the course of formation of the individual terpene derivatives — with the biosynthesis of gibberellin and casbene, with the enzymes influencing the biosynthesis, the conditions of functioning of the enzymes, by examining their localization and regulation as well as the biological function of the compounds discussed.

7. Compounds from Microalgae — Their Influence on the Field of Marine Natural Products (Y. SHIMIZU). The chapter points out that the products of secondary metabolism which are to be found in marine natural products become synthesized not necessarily in the given natural organism but in many cases they get into the organisms examined by the food chain. In this chapter, the author illustrates by means of his own analyses the justification of the above statement related to the occurrence and formation of certain "marine" compounds as for example gorgosterol, and saxitoxin. By referring to the difference between the places of occurrence and biosynthesis, the author warns us to apply the chemotaxonomical outlook — well applied in land natural products — with reservation.

8. Molecular Aspects of Halogen-Based Biosynthesis of Marine Natural Products (W. FENICAL). It is a known fact for a long time halogen elements can be enriched considerably in marine algae. This chapter deals with the possibilities of bromine in-building in *Asparagopsis* and *Bonnemaisonia* species belonging to the Bonnemaisonia family. Bromine occurs in them as an element bound to fatty acids and terpenoids (to mono-, sesqui- and in exceptional cases to diterpenes). The chapter describes the halogen induced effect on biosynthesis in connexion with the formation of certain terpenoids, which take part in the accumulation of bromine.

The compilations prepared by 13 authors can provide useful information on the question of certain details related to the biosynthesis of secondary metabolic products in plants. The aspects that can be generalized will be useful on a wide scale for specialists dealing with plant biochemistry.

I. MÁTHÉ jr.

J. G. HAWKES, R. N. LESTER, and A. D. SKELDING: The Biology and Taxonomy of the Solanaceae. Published for the Linnean Society of London by Academic Press, 1979, 738 p.

This work is the 7th volume of the Linnean Society Symposium Series. It presents the lectures delivered at the international symposium which discussed the biology and the taxonomy of the *Solanaceae* family. The symposium was organised by the Plant Biological

Department of the University of Birmingham, and was held in Birmingham in July 13—17, 1976.

Solanaceae is one of the largest families of flowering plants; quite a series of plants important economically and pharmaceutically belongs to it. The numerous authors from different fields of science have provided — in the light of different viewpoints — a significant survey of this plant family unparalleled even internationally. The book comprises nine sections.

Section I deals with the lectures on taxonomy and floristics. D'ARCY writes on The Classification of the *Solanaceae;* HUNZIKER on the *Solanaceae* of South America; DEB on the *Solanaceae* of India; GLIBE on the *Solanaceae* of Nigeria; HAEGI on Australian genera of the *Solanaceae;* SYMON on the genus Solanum in Australia and HEPPER, on typifying Linnaean names of *Solanaceae.*

Section II discusses ethnobotany. SCHULTES reports on solanaceous hallucinogens and their role in the development of New World cultures; MEHRA on Ethnobotany of Old World *Solanaceae*, and PETERSON on the aboriginal uses of Australian *Solanaceae.*

Sections III and IV present the analysis of *Solanaceae* and their chemical components in the following reports: SCHREIBER: The steroid alkaloids of *Solanum*; BRADLEY, COLLINS, EASTWOOD, IRVINE, SWAN, SYMON on Distribution of steroidal alkaloids in Australian species of *Solanum*; MÁTHÉ, jr. and MÁTHÉ, sen.: Variation in alkaloids in *Solanum dulcamara* L. RODDICK: the Distribution of steroidal glycoalkaloids in cells of *Solanum* and *Lycopersicon*; MILLER and DAVIES: The characteristics of solasodine accumulation in *Solanum khasianum* var. *chatterjeeanum* and *S. laciniatum* grown under field conditions in Birmingham; FORD, McCANCE, and DRYSDALE: The hydrolysis of tomatine by an inducible extracellular enzyme from *Fusarium oxysporum* f. sp. *lycopersici*; EVANS: The Tropane alkaloids of the *Solanaceae.*

HARBORNE and SWAIN provide an overview of flavonoids of the *Solanaceae*; PARMENTIER deals with: The biosynthesis of chlorogenic acid in *Solanaceae*; REID: The diterpenes of *Nicotiana species* and *N. tabacum* cultivars; STEGEMANN: Characterisation of proteins from potatoes, and the Index of European Varieties'; LESTER: The use of protein characters in the taxonomy of *Solanum* and other *Solanaceae.*

In Sections V and VI the anatomy and fine structure as well as morphology and morphogenesis of *Solanaceae* are discussed from a novel aspect in the following articles: SEITHE: Hair types as taxonomic characters in *Solanum*; BESSIS and GUYOT: An attempt to use stomatal characters in systematic and phylogenetic studies of the *Solanaceae*; GENTRY: Pollen morphology of the *Salpiglossideae* (*Solanaceae*); GBILE and SOWUNMI: The pollen morphology of Nigerian *Solanum* species; CHILD: A review of branching patterns in the *Solanaceae*; HAMMOND: Growth regulator interactions on morphogenesis in *Solanum* species; COUTTS: Observations on the isolation, morphology and culture of potato leaf and meristem protoplasts; WESTCOTT, GROUT, and HENSHAW: Rapid clonal propagation of *Solanum curtilobum* cv. *Mallku* by aseptic shoot meristem culture.

The chapters of Section VII, on flower biology, are important mainly for plant breeding, especially because they deal with cultural plants. Such studies are as follows: SYMON: Sex forms in *Solanum* (*Solanaceae*) and the role of pollen collecting insects; QUAGLIOTTI: Floral biology of *Capsicum* and *Solanum melongena*; PANDEY: The genus *Nicotiana*: evolution of incompatibility in flowering plants; HOGENBOOM: Incompatibility and incongruity in *Lycopersicon*; HERMSEN and SAWICKA: Incompatibility and incongruity in tuberbearing *Solanum* species; POCHARD and DUMAS DE VAULX: Haploid parthenogenesis in *Capsicum annum* L.

The chapters in Sections VIII and IX, on the biosystematics of genera and groups as well as culture species, endeavour to present the practical realisation of the subjects dealt with in the preceding chapters. The authors discuss the following topics: PLOWMAN: The genus *Brunfelsia*: a conspectus of the taxonomy and biogeography; AVERETT: Biosystematics of the physaloid genera of the *Solanaceae* in North America; JACKSON and BERRY: Mandragora-taxonomy and chemistry of the European species; HEISER, BURTON and SCHILLINGS: Biosystematic and taxometric studies of the *Solanum nigrum* complex in eastern North America; EDMONDS: Biosystematics of *Solanum* L. section *Solanum* (*Maurella*); ANDERSON: Systematic and evolutionary consideration of species of *Solanum* section Basarthrum; ROE: Dispersal and speciation in *Solanum*, section *Brevantherum*; NEE: Patterns in biogeography in *Solanum*, section *Acanthophora*; WHALEN: Speciation in *Solanum*, section *Androceras*; OMIDIJI: Cross ability relationships between some species of *Solanum*, *Lycopersicon* and *Capsicum* cultivated in Nigeria; RAO: The barriers to hybridization between *Solanum melongena* and some other species of *Solanum*; PEARCE and LESTER: Chemotaxonomy of the cultivated eggplant — a new look at the taxonomic relationships of *Solanum melongena* L.; KHAN: *Solanum melongena* and its ancestral forms; HAWKES: Evolution and polyploidy in potato species; RAMANNA and HERMSEN: Genome relationships in tuberbearing *Solanums*; GRUN: Evolution of the cultivated potato: a cytoplasmic analysis; RICK: Biosystematic studies in *Lycopersicon* and closely

related species of *Solanum*; PICKERSGILL, HEISER and MCNEILL: Numerical taxonomic studies on variation and domestication in some species of *Capsicum*; MCLEOD, ESHBAUGH, and GUTTMAN: A preliminary biochemical systematic study of the genus *Capsicum-Solanaceae*.

A short chapter presents the conclusions of the symposium, then a taxonomical index and a general author index are given at the end of the book.

This book will be extremely important reading for anyone dealing with plants belonging to the *Solanaceae* family. Plant breeders, agricultural research fellows, botanists, pharmacologists, biochemists, etc. may avail themselves of the most recent, up-to-date and important data and knowledge by the world-wide survey provided in this book.

I. MÁTHÉ (sen.)

F. B. CHRISTIANSEN and T. M. FENCHEL: Theories of Population in Biological Communities, Ecological Studies 20. Springer-Verlag, Berlin—Heidelberg—New York, 1977, p. VII + 144.

This is, in some respects, an excellent book. It is quite remarkable how the authors (two leading scientists at the University of Aarhus, Denmark) have been successful in presenting such a huge and rich material in such a concise form. A great deal of current population theory has been summarized succintly and adequately.

The book, however, has a number of rather questionable features. Its focus or aim is certainly much more restricted than the title suggests. The last chapter on "The concept of biological communities" is inadequate and a weak spot of the whole volume. The essential question arises why the authors have placed their brief remarks on community theories at the end of the book, if they really wanted to use "hard community arguments" throughout. (The proper position for such remarks would have been, indeed, in an introductory chapter of some kind.) There is even a strange contrast between the last chapter, an informal epilogue (marked as "Andante melancholico") and the rest of the book ("Allegro con brio"). This is, of course, not only a question of style or a fault of composition. It is rather paradoxical that if the authors are *in petto* so sceptical about the value of community studies carried out so far, why have they chosen their *sujet* and title in the way they did. The Publisher's notes on the flap state that [1] "The book treats theories of biological communities in terms of properties of single species populations and interactions between populations. [2] It emphasizes that a true understanding of communities can only be achieved through the properties of individuals and populations as shaped by natural selection on individual fitness . . ."

Now, the truth is that while *no new theory is proposed*, "old community theories" are mentioned, very superficially indeed, only in a few pages (pp. 130—33), without even quoting either such noted reviews and discussion as [Bot. Rev. *33*: 130—37; *34*: 253—322] or using such important textbook materials as KREBS (1972), WHITTAKER (1973), and so on. The emphasis is clearly neither on community theories nor on the true role of populations within communities. (The real subject matter of the book is population theory, sometimes only "the small group behaviour of populations" as it is understood by a body of human sociologists.) The inductive principle, stressed so exclusively [2] above, is more than doubtful.

Many ecologists, including the reviewer, believe that "a true understanding of community" can only be achieved in both ways, in an inductive and a deductive way, simultaneously. To overemphasise one of these ways, instead of stressing both, is one-sided, even dangerous. The most difficult and exciting problems of ecological research in the years to come are given by some "coupling points" of the different approaches. The original intention of the authors was perhaps to show where these "coupling points" are to be found and how to analyse them. This is, of course, a hopeless task if the deductive way of thinking is underestimated and its methodology is ruled out. By noting but a few points, one can trace the boundaries of a certain range of restriction.

a) The models used throughout this book are based on differential and difference equations. The "stochastic methodology" is rather poorly represented (with the exception of a short but good description of the GALTON—WATSON process). Due to this analysis-oriented view, the authors ignore *in praxi* such important problems as diversity, similarity, classifiability, and so on.

b) For the same reason, the book does not cover a branch of models (like "brocken stick", "sequential breaking", "niche metrics") which has an important bearing on the problem of resource partitioning, the original concern of MACARTHUR and his group. In short, the problems of abundance and abundance structures are omitted. (There is even no reference made to some key works, e.g. DEMPSTER, 1955.)

c) Just from the authors' point of view, it would have been in order to clarify better how population level is to be related to community level. For instance, many readers may

require a clearcut definition of what is to be meant by the "holistic approach" of community theories. According to PRIMAS [J. Math. Biology, *4*: 282], a system is holistic if the states of its subsystems do not determine uniquely the state of the whole system. (In this sense, a Newtonian system is clearly non-holistic.) A community theory of the future will largely depend on how ecologists will be able to define the relations between " guild states" and community states in order to make an operational form of the so-called "individualistic theory".

But out of fairness one must add that such a small volume cannot embrace everything. Despite its misleading title and rather unfortunately worded scope, the book is a very useful summary of a number of population models.

Chapter 1 deals with models of population growth and fitness. Commonplaces (like "HARDY—WEINBERG law" of the simplest form) are kept to a minimum. The parts of Chapter 1 cover density-regulated population growth (1.1), genetical models of population growth (1.2), competition and bacterial growth in chemostats (1.3), reproductive efforts of population (1.4), including COHEN's model on delayed germination of annual plants. Finally, the authors give a very good discussion on "an evolutionary dichotomy" (1.5), on the problems of *r* and *K*-selection. The treatment and the majority of arguments are convincing. The most doubtful point of Chapter 1 is the ambivalent relation between the growth of carrying capacity and that of competitive ability (see also HAFFNER, Ecology, *59*: 864).

Chapter 2 provides a review of interaction between populations, including one-prey-one-predator models (2.1), models of two species competing for resources (2.2), models of mutualistic pairs of species (2.3), linear models of food webs (2.4), competition models with many species (2.5), and simple food web models (2.6). Most models are presented very well, in particular, in the first part of the chapter. Some interpretation of the authors, however, is open to discussion. As the treatment moves from the *simplex* towards the *complex*, the authors become more and more pessimistic about the value of investigations made so far. They very much dislike "systems ecology"; perhaps with reason. It is a little bit disappointing, however, that simulation and related methodology is practically neglected.

Chapter 3 develops some theory on the niche and limiting similarity. This is the strongest part of the book. Chapter 3 concerns such problems as the concept of the niche (3.1), niche dimensions (3.2), the formulation of competition coefficients (3.3), limiting similarity (3.4), the evolution of competing species (3.5), components of the niche (3.6), and evidence from nature (3.6). The most original and interesting part is 3.5; the weakest feature of Chapter 3 is some confusion between "niche dimensions" and "niche components". Part 3.2 begins with the statement: "The niche has three main dimensions; time, habitat, resource." The reviewer believes that it is a *faux pas* to call habitat *a* niche dimension (whatever it may be); according to WHITTAKER, LEVIN and ROOT, habitat itself is a multi dimensional space.

Chapter 4 addresses the problems of the geographically structured populations and migration-extinction equilibria. The summary is useful but not quite original.

Chapter 5 has already been commented upon. FENCHEL and CHRISTIANSEN seem to share the dim view of R. M. MAY [Nature, *269*: 471]: " For multispecies communities, the empirical observations remain largely anecdotal, and the theory remains largely metaphorical." One may ask, once again, why a solution of a differential equation is "less metaphorical" than, let us say, a function of information theory? Why biometrics is considered to be some *corpus alienum ?* One feels that the "calculus-admiration", so fashionable nowadays, is a certain kind of *antithesis* which should be substituted by a synthesis of some kind.

The book contains a number of interesting figures and short "case studies" (partly from FENCHEL) in order to illustrate a number of theoretical points. Efforts have been made to put observation, insight and theory together, and to stimulate the reader's imagination for fitting field results to formulation. The mathematics is clear-cut, but at certain places (e.g. criteria of stability) the naive reader should consult other sources (say, the books of KAPLAN). The list of references, on the whole, is up-to-date and almost adequate, with the exception of some omitted items already mentioned, and others, like PIELOU's book on ecological diversity (1975), or the papers of HARPER. (Surprisingly enough, the authors have neglected an important aspect of the Scandinavian tradition, from RAUNKIAER and KYLIN onwards.) The reference list can be further improved; for instance, instead of RESIGNO—RICHARDSON (1967), it would have been more appropriate to quote the good review by the same authors in the third volume of "Foundations of biomathematics" (ed. by R. ROSEN).

Summarising, this concise book gives a good overview of the present stage of population modelling. It is written in a good style and its outlay is attractive. It can be recommended to a fairly large readership, to biologists and mathematicians alike. The reader, however, should be careful and critical in trying to fill in the gaps of a theoretical framework.

P. JUHÁSZ-NAGY

REINHEIMER G. (ed.): Microbial Ecology of a Brackish Water Environment. Ecological Studies 25. Springer Verlag, Berlin—Heidelberg—New York, 1977. 291 p., 77 figures.

After several years of preliminary investigations in the Kiel Bight (Baltic Sea), intensive examinations set the aim to acquire information on primary production bacterial development, microbial uptake of substances and on the composition and activity of bacteria, fungi and phytoplankton populations. From January 1974 to March 1975, 46 hydrographical, chemical and biological parameters were measured at five stations set up in the Kiel Bight classical and modern methods were applied simultaneously thus the processing and assessing of the data could be carried out in the best possible way. Ten renown specialists participated in the research and in the evaluation of the results.

The introduction and the description of the Kiel Bight as a research area (Chapters 1 and 2) are followed by a detailed hydrographical analysis (Chapter 3), then a discussion and the assessment of the results related to the oxygenous and inorganic nutrients (Chapter 4), to seston and its main components (Chapter 5), and to the organic substances and respiration potential (Chapter 6) are given. A chapter deals with primary production (Chapter 7), which — by its inferences related to the trophication of the Balticum — is a valuable study in itself. Chapter 8 deals with the seasonal dynamics of phytoplankton, while Chapter 9 with fungi, and the subsequent chapters (10—14) with the regional and seasonal distribution, the taxonomy and the metabolism of bacteria. The detailed analysis is justified since bacteria and bacterial processes play an important part in the ecology of the Bay. The activity of the heterotrophic microorganisms is discussed in Chapter 15. The results related to the growth rate of bacteria, and to their biomass productivity, are expounded in Chapter 16, while the assessment of the data on the processes of nitrification, desulphurication and sulphuric oxidation are given in Chapters 17 and 18. Chapter 19 presents the analysis of data of statistical methods concerning the seasonal changes of plankton and of microscopical and chemical conditions. Following the summary of the results. the editor is able to draw general conclusions (Chapter 20).

This excellently edited volume is at the same time a good example . . . to some complex scientific in various fields of research.

ZS. KOMÁROMY

D. L. SOLOMON, C. WALTER (eds): Mathematical Models in Biological Discovery. (Lecture Notes in Biomathematics, 13.) Springer-Verlag, Berlin, Heidelberg, New York, 1977. p. VI + 240.

This is the 13th volume of the well-known series ed. by S. LEVIN. It contains nine studies delivered at the symposium "Contributions of Mathematical Models to Biological Discovery" held during the 141st annual meeting of the AAAS in New York, January 1975. The papers presented in the book are more detailed version of the lectures held at the symposium.

The separate papers are well illustrated and have their own reference list. Unfortunately, the volume has no subject index.

The first paper by W. B. PROVINE deals with the "Role of mathematical population geneticists in the evolutionary synthesis of the 1930's and 40's". The author studied carefully the works of R. A. FISHER, J. B. S. HALDANE, S. WRIGHT, TH. DOBZHANSKY, J. HUXLEY, E. MAYR etc. On the basis of their papers he concluded that the mathematical way of thinking and the models in population genetics had a significant effect on the development of evolutionary thinking. This effect was manifest in at least four ways. Simplified and briefly these are: 1. the models demonstrated the existence of mendelism, natural selection and other processes in natural populations, 2. indicated unfruitful paths and approaches, 3. they pointed out the importance of field research, 4. they created a basis and framework for later field research.

The next six papers deal with specific models from different topics. Their arrangement reflects the hierarchy in biology, that is the subcellular, cellular, incipient multicellular, multicellular individual and supraindividual levels.

Ch. WALTER's paper "Contributions of enzyme models" represent the subcellular level. The detailed descriptions of several enzyme-catalysis models are encased in a historical review. Besides he deals with the validity of the approximations, methods for distinguishing enzyme model and computer based derivations of quasi-steady state rate equations.

In the third paper "Dynamics models of the mitotic cycle: evidence for a limit cycle oscillator" (by S. KAUFFMAN) we can get acquainted with a new model of the mitotic cycle. This

new model is based on the biochemical oscillations using a complex, nonlinear dynamic system approach. Two old models (the so called "causal loop model" and the "central clock model") which contributed to the development of the new one, are briefly outlined, too. Finally the predictive value of the new model is discussed.

A very interesting and remarkable modeling effort of morphogenesis can be found in the fourth paper (A. BABLOYANTZ: Mathematical models for morphogenesis). One of the most exciting problems in biology is how an organism arises from a single cell. To build a model of this phenomenon the author applied partial differential equations and the far-from-equilibrium thermodynamics. These topics are not easy to handle and interpret in a biological context, but may be particularly useful in searching for the motives which lead to pattern formation and morphogenesis. In my opinion the author's concept may be applicable in the pattern study of the supraindividual level, too.

The topic of the fifth paper ("Computer simulation as a means of physiological integration systems" by D. GARFINKEL, L. GARFINKEL and W. T. MOORE) falls on the borderline between biochemistry and physiology. Is it possible to model physiological systems on the basis of several biochemical variables? The authors demonstrate this possibility by the construction of complex models. Both general considerations and concrete examples (liver and cardiac metabolism, cellular growth) are presented. They point also to the possibility of clinical applications of models as described.

The next paper is devoted to the problem of feedback systems ("How models of feedback system can help the practical biologist" by D. S. RIGGS). The importance of feedback systems is unquestionable in biology and in engineering, too. But in studying naturally occurring feedback systems a biologist confronts a lot of difficulties, e.g. the evolutionarily selected regulatory mechanisms are not easy to describe mathematically or "biological feedback systems often comprise many different feedback loops interlinked in complicated ways", etc. In this paper the author describes and illustrates "a comparatively simple technique of mathematical analysis which may allow the biologist to measure the effectiveness of a biological feedback system in spite of the difficulties described above".

The seventh paper ("Reality and models: difficulties associated with applying general ecological models to specific situations" by R. A. GOLDSTEIN) is a short philosophical approach about ecological modeling in general. The author expresses — based on his own experiences — his personal opinion about the historical background, objectives and difficulties of the ecological modeling, emphasizing that "models are research tools".

The penultimate study, entitled "Biochemical models: some triumphs and some defeats" (by H. R. van der VAART) is also a brief essay about the aspects of the interaction between biology and mathematics. It is demonstrated by some examples of successful and/or unsuccessful applications of mathematical methods in biology.

The final paper: "Needs for the future: radically different types of mathematical models" (by M. B. WILLIAMS) concerns the problem, whether our "contemporary mathematical toolbox" is appropriate for biological application. Most of the mathematical structures used in the field of biology were developed for physics, and hence they are not the best. The author suggests "it is our job to develope mathematical tools that are appropriate".

As we could see, the papers of this book deal with various aspects and new ideas of mathematical modelling. They are of high level and need in many case appropriate preliminary training in mathematics. So I would recommend this book above all for specialists.

J. N. NOSEK

ROST, T. L., BARBOUR, M. G., THORNTON, R. M., WEIER, T. E., STOCKING, C. R.: Botany. A brief introduction to plant biology, 1979, John Wiley and Sons, New York. 388 pp., 429 figures

The book can be divided into three parts regarding the subject matter. The first part (Chapter 2—8) introduces us to the morphological and physiological characteristics of plants. The second part (Chapter 9) deals with the fundamentals of plant ecology and the last one (Chapters 10—16) reviews the knowledge of plant taxonomy.

The summaries drawn up point by point at the end of each chapter make easier to memorize the fundamental knowledge. There are five supplementary appendices at the end of the book containing the basic ideas of chemistry and genetics; a glossary, a table of metric equivalents and illustration credits. The first two supplement the knowledge at depth of the previous chapters. The book contains a subject index and an index of genera mentioned in the book, too.

The introduction deals with the scope of botany, and the distinction of plants referring to the differences between the animal and plant cells, and to the separation of organisms during the process of organic evolution.

The second chapter is concerned with the biochemical background of plant life. The role of the principal inorganic and organic matter, enzymes, phases and paths of metabolism (photosynthesis, anabolism, catabolism) are outlined briefly. The control within metabolism, the mechanism of protein synthesis and its control are reviewed in more detail.

The first part of the third chapter deals with the structure of the plant cell, and the second one with the cell cycle. The various cell organelles and the different phases of mitosis and meiosis are well illustrated by drawings and photographs of the electron microscope. DNA replication is also mentioned at the end of the chapter.

The further chapters (4—5—6; 7—8) are closely connected with one another. Both the structure (including morphology and anatomy) of the various organs of the plant body and the physiological processes taking place in them are treated in these chapters.

The function, morphology, and anatomy of each organ (stem, leaf, root, flower, fruit and seed) are reviewed in detail, as well as the development of their tissues. We can read about their modifications and the different anatomy of mono- and dicotyledonous plants, too (Chapters 4 and 7).

The vegetative plant organs absorb the different materials (water, carbon dioxide, oxygen, mineral elements) from the environment and transport them (including the organic materials formed in the plant) through the plant body (Chapter 5). One separate chapter (Chapter 6) is devoted to photosynthesis emphasizing the importance of this primary energy-storing process.

Besides the characteristics of reproductive plant parts (flowers, fruits, seeds), the complete sexual reproductive cycle can also be followed up from to the fertilization to the seed germination in chapter 7. Chapter 8 is concerned with the control growth and development. These processes are influenced and modified by the environment (effect of light, temperature etc.). The development is controlled by hormones at the cell level (e.g. auxins, gibbellerins, cytokinins, etc.).

Plant ecology is summaried briefly in chapter nine. The biotic and abiotic factors, the ecology of population and community level are reviewed briefly, as well as the various vegetation types in the world.

The tenth chapter deals with the investigations of plant taxonomy and evolution. The historical aspects, and the possibilities of plant classification (including the different methods of taxonomic research) can be studied. The organic evolution in the living organisms is also outlined.

The following chapters (from 11 to 16) are devoted to the taxonomy of algae, fungi, bryophytes, lower and higher vascular plants. The life cycles and the typical plants of various taxonomic groups are illustrated by very expressive drawings and photographs. The classification of angiosperms is made according to the Besseyan system which differs from the Soó system used in Hungary.

The book has a good outlay with numerous drawings, electron micrographs and photographs making the text more comprehensible, and it will be useful for every interested in botany.

E. Molnár

R. Soó: Bibliographia synoecologica scientifica hungarica 1900—1972. Akadémiai Kiadó, Budapest 1978, 500 pp.

The book, compiled and edited by Rezső Soó academician, is a pioneering work and there is nothing to equal it. It covers not only phytocenological, zoocenological, and synecological fields but bioclimatology, pedobiology, hydrobiology as well, and even extends to paleosynecology and to production-biology; the first bibliography of several part-sciences has been presented in this book.

The bibliography, which is divided into 27 chapters containing 5642 entries, has been compiled by a team of authors. Professor Soó invited 11 co-workers to compile the bibliography of the individual branch sciences; he himself took part in the collecting and total or partial editing of 20 chapters. The compilation embraces all Hungarian authors, working in fields both inside and outside the country. All the publications from historical Hungary between the 1900s and 1920s have been considered; works written after 1920 by authors outside Hungary are only considered if they contain relevances to Hungary of today.

The chapters of the book are as follows: 1. Synecological monographs, 2. Synecological bibliographies, 3. History of phytocenology, 4. Bibliography of ecologists, 5. Congresses, synecological excursions, 6. Terminology, phytocenological methodics, 7. Quantitative synecology, 8. Synecology of plants, 9. Synecology of forests, 10. Phytocenology and geography, 11. Bioclimatology, 12. Phytocenology and pedology, 13. Pedomicrobiology, 14. Hydrobiology, 15. Syndynamics, experimental phytocenology, 16. General syntaxonomy, 17. Synecology and algal communities, 18. Cryptogamic communities, 19. Communities of spermatophytes, syntaxonomy, 20. Synchorology, 21. Cenology and agriculture, 22. Floristical works, containing cenological data, 23. Paleobotany, 24. Production of terrestrial vegetation, 25. Zoological synecology, 26. Zoological synchorology, 27. Nature conservation.

It is to be noted that the various chapters are not of equal value, there is no evenness concerning their elaboration either. Chapters 8 and 9 are partly overlapping in respect of their themes, which is attributable to the fact that these have been written by various authors; the latter chapter comprises the synecological implications of forest-cultivation and afforestation. Dividing the voluminous phytocenological material, (up to the 1960s) had formed great traditions, into special chapters (12, 15, 19, 20) is favourable; Chapter 10 on the other hand is to a certain extent mixed. An outstanding merit of Chapter 20 is that a list of vegetation maps has been attached. Valuable parts of the compilation are the chapters on pedomicrobiology (Kecskés, M., 529 entries), resp. hydrobiolgy (Berczik, Á., 848 entries), which are in themselves considerable and quite comprehensible bibliographies have been structured and divided in a similar way (sub-chapters: monographs, history, congresses, terminology, methodology, detailed part). The articles on bioclimatology (agrometeorology, phenology amount to altogether 300.

The main part of the chapter (24) on terrestrial vegetation production is the subchapter on the production of crop plants (Hunyadi, K., 771 entries); as its shortcoming we can mention its undividedness which makes surveying the topic difficult. Besides, the subject of numerous articles (for example, that on nutrition biology, growth biology, genetics, phytochemistry, methodology, etc.) included in the section represents some boundary discipline. The articles drawn into the sub-chapter on plant microelement-contents contribute to autecology. The chapter on paleobotany are divided according to: paleophytocenology and cenology (tertiary and quaternary, synchronology, palynology). The two chapters on animal ecology enumerate 843 titles. The 36 articles on nature conservation (which is a selection of the total literature) include, in addition to botanical and zoological aspects, pedological implications as well.

The book documents impressively towards the world outside Hungary the works and trends of scientific activity of Hungarian ecologists. It has been built on fundaments broader than any of the Hungarian bibliographies of similar subjects published so far, and accordingly the range of its users will have to be very large: it may become a frequently used handbook of great assistance to cenologists, ecologists, paleobotanists, microbiologists, hydrobiologists, agricultural specialists, bioclimatologists, and for those dealing with nature conservation.

G. Fekete

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ACTA BOTANICA

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Резюме

ИЗУЧЕНИЕ АНАТОМИИ СОСУДОВ ТРОПИЧЕСКИХ КУБИНСКИХ ВИДОВ ДЕРЕВЬЕВ, ОТНОСЯЩИХСЯ К РАЗЛИЧНЫМ СЕМЕЙСТВАМ

К. БАБОШ

В статье обсуждаются анатомические признаки сосудов 23 тропических видов деревьев и кустарников, которые относятся к 21 различным семействам. Эти виды происходят с Кубы и 6 из них эндемические.

СЕЗОННОЕ ИЗМЕНЕНИЕ РЕДУЦИОННЫХ ОРГАНИЧЕСКИХ ВЕЩЕСТВ В ЛИСТЬЯХ КУСТАРНИКОВ

Ч. БЕРЕШ

В связи с комплексными экологическими исследованиями по теме **"Síkfőkút Project"** в статье излагаются данные по сезональной динамике редукционных органических веществ в листьях четырех доминантных видов кустарников дубового леса ***Quercetum petraeae-cerris*** Кроме этого автор исследовал влияние на эти вещества температуры перед взятием образцов, влияние количества осадков и числа солнечных часов. Полученные результаты свидетельствуют о том, что в случае ***Cornus mas***, ***Acer campestre*** и ***A. tataricum*** влияние температуры первично на образование углеводов, а осадки влияют только на количество свободных легко мобилизирующихся сахаров. Однако количество концентрации редукционных веществ у ***Ligusrtum vulgare*** в первую очередь определяется количеством осадков. На изменение количества фенолов и олифенолов большое влияние оказывает количество солнечных часов и формирование температуры. Эти вещества в весенний период можно найти в большом количестве в тех кустарниках, которые менее повреждаются фитофагом.

НОВЫЕ НАЗВАНИЯ И НОВЫЕ ВИДЫ В КУБИНСКОЙ ФЛОРЕ II

А. БОРХИДИ

Автор перечисляет необходимые номенклатурные изменения относящиеся к кубинской флоре а также публикует несколько новых комбинаций и новых названий. Новые комбинации следующие:

Schizachyrium reedii **(Hitchc. et Ekm.) Borhidi et Catasus,** ***Schizachyrium parvifolium*** **(Hitchc.) Borhidi et Catasus,** ***Garcinia aristata*** **(Griseb.) Borhidi,** ***Garcinia bakeriana*** **(Urb.) Borhidi,** ***Garcinia cincta*** **(Urb.) Borhidi,** ***Garcinia cubensis*** **(Borhidi) Borhidi,** ***Garcinia moaensis*** **(Bisse) Borhidi,** ***Garcinia ophiticola*** **(Borhidi) Borhidi,** ***Garcinia polyneura*** **(Urb.) Borhidi,** ***Garcinia revoluta*** **(Urb.) Borhidi,** ***Garcinia ruscifolia*** **(Griseb.) Borhidi,** ***Garcinia ruscifolia*** **var.** ***linearis*** **(Borhidi) Borhidi,** ***Chionanthus acunae*** **(Borhidi et Muñiz) Borhidi,** ***Chionanthus moncadae*** **(Borhidi et Muñiz) Borhidi,** ***Chionanthus bumelioides*** **(Griseb.) Stearn ssp.** ***obovalis***

(Borhidi et Muñiz) Borhidi, *Micromeria suborbicularis* (Alain) Borhidi, *Isidorea ophiticola* (Borhidi) Borhidi et Moncada, *Isidorea acunae* (Borhidi) Borhidi et Moncada. Новые названия следующие: *Terminalia bipleura* nom. nov., *Garcinia clarensis* nom. nov., *Garcinia pungens* nom. nov., *Garcinia serpentini* nom. nov.

Из семейства *Rubiaceae* автор описывает следующие 5 таксонов: *Isidorea microphylla* sp. n., *Schmidtottia monticola* sp. n., *Sch. shaferi* ssp. *neglecta* ssp. n., *Sch. elliptica* ssp. *oblongata* ssp. n., *Sch. cucullata* sp. n.

НОВЫЙ РОД *ACUNAEANTHUS* ИЗ СЕМЕЙСТВА *RUBIACEAE*

А. БОРХИДИ, М. ЯРАИ-КОМЛОДИ, М. МОНКАДА

Авторы статьи при помощи подробных морфологических и палинологических исследований определили, что два вида рода *Neomazaea* (*Rubiaceae*, *Rondeletieae* триба) *N. phialanthoides* (Griseb.) Kr. et Urb. *N. tinifolia* (Griseb.) Urb. на родовом уровне отличаются друг от друга. *Neomazaea tinifolia* представляет новый род из семейства *Rubiaceae*, который в этой статье авторы описывают и посвящают великому кубинскому ботанику Й. Акуня Гале под названием *Acunaeanthus*.

ИЗУЧЕНИЕ-NICHE НЕКОТОРЫХ РАСТИТЕЛЬНЫХ ВИДОВ ТРАВЯНИСТЫХ СООБЩЕСТВ, VII

Г. ФЕКЭТЭ, З. ТУБА, И. ПРЕЧЕНЬИ

Авторы изучали фотосинтетические пигменты (каротин, хлорофилл а, хлорофилл б, ксантофил) у 7 многолетних видов песчанно-пустынного травянистого сообщества) методом тонкослойной хроматографии, каждый вид исследовали в 7 повторениях). Своими исследованиями авторы хотели узнать и описать меру световой-пигментноэкологической выносливости и степень сходности видов. Значительная дисперсия фотосинтетической концентрации пигментов внутри одного вида можно присвоить влиянию места обитания. Дисперсия релативных значений, относящихся к общему содержанию пигмента гораздо меньше. На основании расчета обобщенного расстояния было определено, что *Thymus* sp. и *Festuca vaginata* покрывают большинство видов, они по пигментоэкологии скорее всего генеральные виды. С другой стороны *Potentilla arenaria*, *Euphorbia seguieriana* и *P. bulbosa* — экологические специалисты.

PLATANUS NEPTUNI (ETT) BŮŽEK, HOLÝ ET KVAČEK В ВЕНГЕРСКОМ ОЛИГОЦЕНЕ

Л. ХАБЛИ

Автор описывает 2 новых места обитания *P. neptuni* в Венгрии, после того, как этот вид был известен по месту его обитания в Чехолавакии, Германии и Франции. Одно из мест обитания происходит из слоев нижней олигоцен-Нижний Кишцелли, Будапешт, а другое из слоев эгерского высшего олигоцена (Ноградверёце, Северная Венгрия). Автор, кроме подробных макроморфологических исследований изучил эпидермис листьев на ископаемом материале в первый раз используя этот метод в Венгрии. Сравнив отечественные и заграничные результаты по этим исследованиям автор сделал выводы по экологии и климатологии.

НОВЫЕ *SCENEDESMUS* ТАКСОНЫ В БУДАПЕШТСКОЙ ЧАСТИ ДУНАЯ (1588—1674 ПОГОННЫЙ КИЛОМЕТР)

Т. ХОРТОБАДЬИ

Автор с 1970 до 1976 года исследовал будапештскую часть Дуная с точки зрения альгологии и водной бактериологии. Им были открыты многие для науки микроорганизмы о которых автор уже частично изложил в своих статьях. В настоящей статье автор описы-

вает новые таксоны *Scenedesmus*, которые он наблюдал в будапештской части Дуная между 1588 и 1674 погонным километром. Их количество было равно 35, из них 4-новый вид, 12- новый вариетас и 19-новая форма: *Scenedesmus kövesii*, *Sc*, *longistriatus*, *Sc. pseudointermedius*, *Sc. saltator*, *Sc. carinatus var. brevicaudatus*, *Sc. ellipsoideus* var. *spinosus*, *Sc. intermedius var. crassibicaudato-granulatus* f. *longispinosus*, *Sc. Naegeli* var. *acaudatus* f. *heterogranulatus*, *Sc. nanus* f. *granulatus*, *Sc. opoliensis* var. *crassicaudato-granulatus* f. *danubialis*, *Sc. opoliensis* var. *crassicaudato-granulatus* f. *extensus*, *Sc. pécsensis* var. *bicaudato-granulatus* f. *danubialis*, *Sc. pécsensis* f. *heterocaudatus*, *Sc. similagineus* f. *heterogranulatus*, *Sc. similagineus* f. *simplex*, *Sc. Soói* f. *elegans*, *Sc. Soói* f. *robustum*.

ИССЛЕДОВАНИЕ ПЫЛЬЦЕВЫХ ЗЕРЕН СОВРЕМЕННЫХ *PALMAE*

М. КЕДВЕШ

В статье обощены результаты исследования пыльцевых зерен, проведенные на 100 видах 57 родов. Большая часть исследованных видов — monosulcat, но встречаются типы trichotomosulcat и disulcat, ulcerat. На основании исследований световым микроскопом можно отделить типы и группы, которые полезны для определения ближайших ботанических связей ископаемых форм.

ПРОСТРАНСТВЕННЫЕ ПРОЦЕССЫ В ТРАВЯНИСТЫХ СООБЩЕСТВАХ

Е. Н. МОЛНАР, Я. Н. НОСЕК

Статья занимается некоторыми пространственными изменениями, характерными для вегетации (число особей, покров и биомасса) на популяционном уровне. Первая часть работы заключает в себе продолжение уже обсужденных исследований на уровне сообщества. Подбор образцов авторы проводили на 5 квадратах различной величины (0,04 м²—1 м²), расположенных случайно и независимо друг от друга. Исследование характеристики, за исключением некоторых случаев, не показали систематических изменений в зависимости от времен года. Хотя по изменениям исследованных доминантных видов сообщества нельзя было судить о целом сообществе.

Между различными характеристиками некоторых видов имеется сильная положительная корреляция. На основе полученных результатов, популяция *Fumana* отличается от других ее видов.

Между двумя характеристиками, на основании сильной и сигнификантной корреляции, можно рассчитать одну оценку из другой.

Сильную, позитивную, линейную связь можно было определить между характеристиками и площадью.

Авторы дают процентное отклонение измеренных и рассчитанных значений характеристик, относящихся к площади 1 м² и к площади отбора образцов.

ПРОДУКТИВНОСТЬ И ФОТОСИНТЕТИЧЕСКАЯ ПЛАСТИЧНОСТЬ У НЕКОТОРЫХ ВИДАХ ТРАВЯНИСТОГО СООБЩЕСТВА

А. Х. НАДЬ, А. ХОРАНСКИ

Авторами был исследован тип ассимиляции CO_2 у 48 видов песченно-степного сообщества в Киш - Теце) Вацратот около Будапешта) в различные сезоны, после дождливого и сухого периода на протяжении 4 лет (1976 - 1979). Из исследованных 48 видов на основе отношения ферментной активности, один вид *Cynodon dactylon* в весенний период (конец мая) имел тип ассимиляции C_4. Различные виды на основе их высокой активности PEP-карбоксилазы были сгруппированы в так называемые интермедиерные типы. После сухого летнего периода имелось только 30 видов сообщества, которые были в подходящем для опыта состоянии. Первично активность RUBP-карбоксилазы уменьшалась в

большой степени у большинства из некоторых видов категоризированных как интермедиеры и сохранялась активность PEP-карбоксилазы на высоком уровне и в зависимости от этого было возможно отклонение в типе ассимиляции C_4. Между этими видами можно было выделить следующие: ***Carex praecox***, ***Festuca vaginata***, ***F. wagneri***, ***Koeleria majoriflora***, ***Phleum phleoides***.

ИССЛЕДОВАНИЕ ФИТОПЛАНКТОНА БАЛАТОНА В ТЕЧЕНИЕ КОРОТКОГО ПЕРИОДА ЛЕТОМ 1976, 1977 И 1978 ГОДА В ТИХАНЕ

Ю. ПАДИШАК

Автор в течение 1—1 месяца лет 1976, 1977 и 1978 годов проводила каждодневные исследования образцов фитопланктона Балатона у Тихани. Колебание количества водорослей, относящихся к типам ***Cyanophyta*** и ***Chlorophyta*** значительно выросло. Содержание хлорофилла а более тесно коррелировало с содержанием сестона, чем с числом особой водоросли. Статья указывает на некоторые явления связанные с эвтрофизацией Балатона а также на стадийность прохождения сезональной сукцессии, и на определенные влияния, сказывающие замутнением озера.

ИЗУЧЕНИЕ-NICHE НЕКОТОРЫХ РАСТИТЕЛЬНЫХ ВИДОВ ТРАВЯНИСТЫХ СООБЩЕСТВ, VI НОВЫЙ ПОДХОД К ПРОБЛЕМЕ ЭКОЛОГИЧЕСКОЙ СПЕЦИАЛИЗАЦИИ И ГЕНЕРАЛИЗАЦИИ

И. ПРЕЧЕНЬИ, Г. ФЕКЕТЕ, Н. Е. МОЛНАР, Е. МЕЛКО, К. ВИРАГ

Вопросы экологической специализации на растениях едва изучали. При помощи экологической ширины niche степень специализации может быть выражена на основе конкретных экологических измерений, что авторы и выразили в своих ранних работах. В дополнении к этому авторы дают предложение для выражения количества информации. Высокое количество информации — признак экологической специализации. Исходя из того, что междувидовые ассоциации должны отражать экологические влияния, авторы исследовали ISC матрикс центроидным методом и специальные или генеральные свойства некоторых видов оценивали коммунальностями или значением $1-h^2$. Порядок видов на оси коммунальности ($1-h^2$), (на основе 21 данных) мог изменяться по комплекту видов.

КРАТКОВРЕМЕННЫЕ ИССЛЕДОВАНИЯ БАКТЕРИОПЛАНКТОНА НА БАЛАТОНЕ В ТИХАНЕ

Л. Г. ТОТ

Автор проводил кратковременные исследования летом 1976 и 1977 годов бактериопланктона Балатона при помощи взятия образцов. Бактериопланктон состоит из 99% плывущих колоний, в которых бактерии находятся вместе в процессе деления. 80% колоний содержали в тоже самое время деляющиеся клетки и популяции прошли все стадии нормального цикла развития. Ограничение роста колоний по всей вероятности зависит от этих фактов. Взбалтывание питательных веществ со дна, вызванное грозой предыдущего дня активизирует синкронное деление клеток. Это предположение автор подтверил Path-анализом. В дальнейшем автор открыл сукцессию морфологических групп. Взятие кратковременных образцов дало возможность рассчитать время турновера. Снижающееся время бактериального турновера и измеренное на водяной колонке растущее количество содержания угля, доказывает ускорение эвтрофизации Балатона.

ВЬЕТНАМСКИЕ МХИ I

ТРАН НИНЬ

В статье перечисляются 107 видов, из которых 6 новые для Индокитая, 5- для Вьетнама. Исследованные экземпляры хранятся в гербарии Ханойского Университета, а также в гербарии Эгер—Вацратот (EGR).

ИЗУЧЕНИЕ СВЯЗИ МЕЖДУ ВЕРТИКАЛЬНЫМ СВЕТОМ МНОГОЯРУСНОГО ЛЕСНОГО СООБЩЕСТВА (ДУБОВЫЙ ЛЕС) И ФОТОСИНТЕТИЧЕСКОЙ СТРУКТУРЫ ПИГМЕНТА (ХЛОРОФИЛЛ И КАРОТИНОИДЫ)

З. ТУБА, Й. НИЛАШ

Авторы провели изучения связи между разделением относительной интенсивности света (структура света), концентрацией пигментов (mg/g) и состава пигментов (mg/dm²) (структура пигментов) у видов, составляющих ярусы в сообществе *Quercum petraeae-cerris*, в аспектах лета и ранней осени. За исключением осеннего хлорофилла в обоих аспектах в случае всех пигментов) хлорофилл-а, хлорофилл-б, хлорофилл а + б, каротиноид, общее количество пигментов) существует тесная значительная связь между относительной интенсивностью света и вертикальным разделением фотосинтетической концентрации пигментов на основе которой можно говорить о совместной световой пигментной структуре. По сравнению с хлорофиллом а у других пигментов имеется более тесная связь со структурой света. Очень заметно осеннее увеличение корреляции каротиноидов под действием света. Между относительным освещением и разделением состава пигментов не было значительной связи.

ЦИТОФОТОМЕТРИЧЕСКИЕ ИЗМЕРЕНИЯ ДНК В ПОЛИПЛОИДНОМ РЯДУ ПАПОРОТНИКА, ОТНОСНЯЕГОСЯ К РОДУ *CYSTOPTERIS* BERNH.

Г. ВИДА, Й. МОХАИ

Авторы, проводя цитофотометрические измерения, определили в полиплоидном комплексе папоротника *Cystopteris fragilis* количество ДНК приходящееся на одну клетку, окраской по Фельгену в G_2 ядрах клеток. Были исследованы ди-, три-, тетра-, пента-, гекса-, и октоплоидные клетки. Значения измеренной ДНК соответствовали ожидаемому в результате полиплоидии количеству ДНК. Немотря на высокую степень полиплоидии авторы не заметили отклонения от ожидаемого значения ДНК, даже из-за инактивации или элиминации явно изобильного генетического материала.

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